JOINT INDUSTRIAL PRETREATMENT

CITY OF INDIANAPOLIS
DEPARTMENT OF PUBLIC WORKS

INDUSTRIAL PRETREATMENT PROGRAM

Peat, Marwick, Mitchell & Co.

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MARCH 1983

TASK 14 REPORT
DRAFT

April 6, 1983

City of Indianapolis
Department of Public Works
2460 City-County Building
Indianapolis, IN 46104

File No. 1180.0010

Attention: Mr. Richard Rippel, Director

Subject: Indianapolis Pretreatment Project
Task 14 Report: Joint Pretreatment Evaluation

Gentlemen:

Enclosed is the Draft Task 14: Joint Pretreatment Evaluation Report. This report analyzes the need for pretreatment in Indianapolis and evaluates the feasibility of utilizing joint facilities to pretreat wastes from several industries at once.

This Task 14 Report discusses the need for pretreatment to avoid industrial pollution of the White River through Combined Sewer Overflows (CSO's), as well as the need for pretreatment to meet proposed industrial discharge limits. It is found that the effect of dilution during storms is sufficient to mitigate risks to water quality due to industrial discharges that flow through CSO's rather than through the city treatment plants. However, reduction of CSO's will avoid risk of river impact due to accumulations of industrial pollutants in solids deposits flushed from sewers during storms. The report recommends that no joint pretreatment facilities be constructed to mitigate CSO problems.

The analysis of the needs for joint pretreatment to meet proposed discharge limits identified a group of centrally located metalplaters as potential candidates for inclusion in a joint pretreatment project. Following selection of a process train based on technical feasibility, an economic comparison was made between joint and separate pretreatment for these industries. The comparison indicated that piping and waste transportation costs counterbalance savings due to economics of scale. As a result, there is insufficient economic incentive to overcome the institutional problems involved in joint pretreatment. It is not recommended that the City of Indianapolis sponsor such a facility.

JMM received significant aid in the development of this report from the firm of Howard, Needles, Tammen, and Bergendoff, which conducted the 1981 CSO monitoring study and supplied drafts of their report to JMM.

The information in this report represents part of the foundation of the industrial pretreatment program for the City of Indianapolis by analyzing the potential economic impact of pretreatment on the City. Together with the other

Pretreatment Project Reports, it provides Indianapolis with the documentation necessary to technically justify the regulation of the discharge of industrial pollutants to City sewers. If you have any questions, please call me.

Very truly yours,

Christopher B Cain

Christopher B. Cain
Project Engineer

/gl
Enclosure

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INDIANAPOLIS PRETREATMENT
TASK 14 REPORT

JOINT PRETREATMENT EVALUATION

CHAPTER 1

CHAPTER 1

INTRODUCTION

BACKGROUND OF PRETREATMENT PROJECT

The City of Indianapolis has recently started up two large advanced waste treatment (AWT) facilities to treat the wastewater produced by the citizens and industry located within Marion County, Indiana. There are several large industries located in the Marion County area, including numerous pharmaceutical plants, automative assembly plants, and other heavy industries. The potential for priority pollutant discharge is significant, and the need for an industrial wastewater pretreatment program has been demonstrated.

Due to the large number of industries, it is important that the ordinance, which limits industrial discharges, be properly documented to maximize the utilization of the City's wastewater treatment facilities. The industries in Indianapolis accept that they must discharge wastewater that is suitable for treatment in the advanced waste treatment facilities. However, they are also concerned about the potential cost impact that the installation of pretreatment facilities would have. As a result, substantial efforts have been made to provide the technical information required to justify the establishment of discharge concentration limits on various pollutants tailored particularly for the City of Indianapolis. In spite of the promulgation of categorical pretreatment standards by the U.S. Environmental Protection Agency (EPA) for certain industries located in Indianapolis, it is important to establish a reasonable and enforceable local ordinance to protect the operation of the $250,000,000 AWT facilities in Indianapolis.

Additional concerns in the Indianapolis area involve the discharge of up to 250 mgd of treated wastewater into the White River where the ten-year, seven-day low flow is approximately 35 mgd. Thus, the potential concerns for the impact of these discharges is significant for this reach of the White River. The work required to characterize the potential impact is being conducted concurrently with the to start-up of the AWT plants to establish baseline data to evaluate the improvements in in the White River system attributable to the AWT plants.

The purpose of the pretreatment project is to establish a technically sound Sewer Use Ordinance for discharges to the Indianapolis wastewater system. The primary emphasis has been to establish meaningful priority pollutant discharge limits to protect the new AWT facilities. Substantial funds have been committed to both the planning and construction of these facilities. Ongoing efforts are being expended for the control of combined sewer overflows and for the study of sludge management alternatives. Both of these studies interact with the industrial pretreatment program due to the impact of priority pollutant accumulation and/or discharge via these routes. Compatible levels of priority pollutants which enter the treatment facility are either discharged in the effluent, accumulated in the sludge, or degraded or removed during treatment. Higher levels of these materials can result in violation of the City's NPDES permit due to upset of the treatment facilities and interference with the removal of conventional pollutants or impact on the economics of the feasibility of sludge disposal.

SCOPE AND OBJECTIVES

The objective of this Joint Pretreatment Report is to evaluate the feasibility of reducing the cost of pretreatment required in Indianapolis by construction and operation of joint pretreatment facilities which would receive, treat, and dispose of wastes from a number of separate industries. The scope of the work reported here includes the following elements:

- Review the distribution of industries throughout Indianapolis by location and by character is discharge. Identify any situations in which a number of similar industrial that may require pretreatment are located in a concentrated area.

- Review the impact of industrial wastes on CSO discharges to the White River. Identify any situations in which joint pretreatment or re-sewering of a limited group of industries could yield a significant improvement in river water quality.

- Screen alternatives and select a process train for a feasible joint pretreatment facility.

- compare the costs of joint pretreatment to those of separate pretreatment meeting the same discharge requirements.

The Joint Pretreatment Report is intended to be a vehicle for economic evaluation of the impact of pretreatment upon the industries in Indianapolis, as well as on the City directly. In it, the industries that will require new pretreatment facilities to meet the proposed discharge limits are identified and characterized. Then a facility is proposed that will meet much of the City's need for pretreatment. In this way, the City is provided with a relatively specific yet brief summary of the expected impact of the proposed discharge limits to be included in the revised Sewer Use Ordinance, and at the same time, it is also provided with an engineering solution to the pretreatment problem.

RELATIONSHIP WITH OTHER PRETREATMENT REPORTS

Since the pretreatment project was initiated in the fall of 1981, the project team has completed a number of major study activities and made progress toward completion of others.

Peat, Marwick, Mitchell, & Co. (PMM) has completed the process of surveying the industries in Indianapolis and publishing the sewer user list in the Task 1 Report. PMM has also issued the Task 2 Report outlining notification procedures to be implemented in Indianapolis to inform affected industries of regulatory actions, as well as the Task 5 Report presenting the Draft Sewer Use Ordinance for the City. James M. Montgomery, Consulting Engineers, Inc. (JMM) has conducted a wastewater sampling and priority pollutant analysis program at the two existing Indianapolis treatment plants, and has reported the resulting wastewater characterization in the Task 3 Report. JMM has also designed, constructed, and started up a pilot Advanced Wastewater Treatment (AWT) plant on-site in Indianapolis, and has completed a schedule of experiments designed to provide the technical information needed to support a revised Sewer Use Ordinance.

The fundamental goal of the pretreatment project is the control of impacts caused by industrial waste discharges to City sewers in accordance with EPA and State of Indiana guidelines. The primary tool for control of industrial waste discharges to City sewers will be a thoroughly reviewed and revised Sewer Use Ordinance for the City of Indianapolis which is presented in the Task 5 Report. The ordinance will be based upon the existing ordinance, upon EPA pretreatment regulations and categorical pretreatment standards, and upon the technical information developed during the City's pretreatment project. The EPA has published a list of priority pollutants which it intends to regulate under municipal pretreatment programs in the United States. The previously published Task 3 and Task 4 Reports identified those priority pollutants which will need to be regulated in Indianapolis, by determining whether the compounds are or could be expected to be present in City wastewater, and whether they could impact the AWT's or the River. The previously published Task 1 Report presented the list of Industrial Users of the Indianapolis City Sewers as well as the available data defining the pollutants in their discharges. The Monitoring Report puts the User List from the Task 1 Report together with the list of important pollutants from the Task 3 and Task 4 Reports and develops a program of sampling and analysis that will enable the City to enforce compliance with the Industrial Waste Ordinance.

The Task 15 Water Quality Report summarizes both the previously existing data on water quality in the White River and the data collected by analyzing river water and sediment samples as part of this pretreatment study. The Water Quality Report also summarizes the water quality modeling performed using the computer to describe the behavior of priority pollutants in the White River.

AUTHORIZATION

This report has been completed in accordance with the terms and agreement between the City Indianapolis and James M. Montgomery, Consulting Engineeers, Inc., in the Final Contract for Developing a Municipal Pretreatment Program, dated July 13, 1981.

ABBREVIATIONS

To conserve space and improve readability, the following abbreviations have been used throughout this report:

AWT	advanced wastewater treatment
ADWF	average dry weather flow
BOD	5-day Biochemical Oxygen Demand
City	City of Indianapolis
Department of Health	Indiana State Department of Health
DPW	City of Indianapolis Department of Public Works
EPA	U.S. Environmental Protection Agency
°F	degrees Fahrenheit
ft	feet
gal	gallons
GC	gas chromatagraph
GC/MS	gas chromatagraph/mass spectrophotometer
gpd	gallons per day

gpm	gallons per minute
hp	horsepower
hr	hour
in	inches
lbs/day	pounds per day
mil gal	million gallons
mgd	million gallons per day
mg/l	milligrams per liter
min	minutes
mph	miles per hour
PDWF	peak dry weather flow
POTW	Publicly Owned Treatment Works
ppm	parts per million
psi	pounds per square inch
PWWF	peak wet weather flow
rpm	revolutions per minute
sq ft	square foot
TDS	total dissolved solids
$\mu g/m^3$	micrograms per cubic meter
$\mu g/l$	micrograms per liter
yr	year

CHAPTER 2

JAMES M. MONTGOMERY, CONSULTING ENGINEERS, INC.

CHAPTER 2

SUMMARY AND RECOMMENDATIONS

GENERAL SUMMARY

This Task 14 Joint Petreatment Evaluation Report presents the results of an analysis of the pretreatment needs in Indianapolis both to meet the industrial discharge limitations proposed for the revised Sewer Use Ordinance and to prevent impact on the White River due to industrial wastes in Combined Sewer Overflows (CSO's). The report proposes engineering alternatives to satisfy the identified pretreatment needs.

This report is organized in two main sections. The first section characterizes the industries in Indianapolis which are expected to discharge industrial pollutants at concentrations above the proposed ordinance limitations. The report also characterizes the industrial pollutants that are included in CSO's. On the basis of this characteristization and review, recommendations are made as to the pretreatment required to ensure ordinance compliance and prevent river impact. The section second of the report proposes a joint pretreatment facility for treatment of metalplater wastes in a specific area within Indianapolis. Conceptual designs and cost estimates are prepared to enable a comparison between the joint pretreatment approach and the separate pretreatment approach. This section thus presents data useful for defining the impact of pretreatment regulations on industries in Indianapolis.

NEEDS ANALYSIS

Chapter 3 of this report reviews the industries in Indianapolis and the CSO data collected during the CSO study and determines the need for pretreatment in Indianapolis. The industries are characterized in terms of which pollutants are discharged above proposed ordinance limitations, and in terms of size, location, and the processes employed by each industry for production, as they affect the waste discharge. Twenty-one industries are identified that are expected to discharge above the ordinance limitations based upon data collected during the industrial waste survey. These industries fall into two basic groups. The first group includes metalplaters which discharge cyanide and toxic metals in excess of the allowable limits, and the second group consists of industries discharging oil and grease above the 200 mg/l concentration, which should be the maximum concentration for effluent from a properly operated gravity oil separator. Based upon the analysis of size, location, and process similarities, five electroplaters are identified as being candidates for joint pretreatment. The remaining industries identified as probably requiring pretreatment are large, are distributed widely over the City of Indianapolis, and have dissimilar processes, so that they would choose to pretreat separately rather than jointly based upon economic and administrative considerations.

The analysis of the CSO data for industrial pollutants collected during the 1981 CSO study results in the conclusion that, except for copper, cadmium, and oil and grease, there is no danger of industrial pollutant impact on the White River due to CSO's. In the case of cadmium, there is no risk of violation of the (0.1)* LC-50 fathead minnow water quality criteria, although the EPA acute water quality criteria may be violated due to CSO discharges. This is judged to not be sufficient grounds for correction of CSO problems, primarily because the EPA acute criteria is based upon inappropriate organisms (trout and salmon). Although it is projected that CSO discharges will result in oil and grease concentrations in the White River above the 5 mg/l criteria suggested for prevention of visible oil films, the oil and grease concentrations will not be high enough to cause risk of toxicity in the river, and aesthetically unpleasant oil films will be effectively prevented both by the high storm flows which accompany CSO events and by the attachment of the oil to solids which will subsequently settle in the river. The incorporation of copper in the suspended solids in the CSO flows will tend to mitigate the toxic effect of this compound, so that even though CSO discharges will result copper concentrations in the river above the (0.1)* LC-50 fathead minnor water quality criteria, no toxicity is expected to develop. On this basis, the analysis of the CSO data collected to date has resulted in the recommendation that no pretreatment is required to prevent impact on the White River due to industrial pollutants and CSO discharges.

JOINT METALPLATER PRETREATMENT

Chapter 4 of this report presents a brief process selection discussion which develops a probable best alternative treatment process scheme for a joint metalplater pretreatment facility in Indianapolis. This facility would be owned and operated by the City of Indianapolis with the costs of construction and operation billed back to the industries served by the facility. The joint metalplater treatment facility will include cyanide destruction by chlorination, chromium reduction using sulfur dioxide, and metals precipitation achieved by caustic addition followed by clarification. The sludge produced in the joint metalplater pretreatment plant would be dewatered to produce a truckable cake which would then be disposed of, probably in landfill.

Conceptual designs for separate pretreatment plants for the five industries expected to be served by the joint pretreatment facility are presented along with the conceptual design for the joint facility. The conceptual designs are presented in the form of process flow diagrams and major equipment lists. Finally, cost estimates are prepared both for the joint pretreatment facility and for the five separate pretreatment facilities taken together. This facilitates a comparison between the joint and separate approaches to metalplater pretreatment in Indianapolis. The comparison indicates that although there are significant economies of scale which lower the cost for treatment in a joint facility as compared to separate facilities, the economic benefit is counterbalanced by the cost of pipelines for transporting the process waste water from the source industries to the joint facility. The cost for a joint metalplater facility is found to be $1,401,400, as compared to $1,351,000 for equivalent separate pretreatment facilities.

RECOMMENDATIONS

1. The City of Indianapolis need not require pretreatment specifically to prevent impact on the White River due to industrial discharges and CSO's.

2. An awareness of the potential benefit to be derived from any reduction in CSO's due to the reduction of discharge of industrial pollutants which accumulate in solids deposits in the sewers should be included in any City of Indianapolis evaluation of CSO elimination plans. Although such solids deposits cannot be prevented by pretreatment, and although they pose no great hazard to the White River, they do represent a measureable impact which could be avoided through elimination of CSO's.

3. The City of Indianapolis should not construct and operate a joint metalplater treatment facility, because this approach will not provide pretreatment at a significantly lower cost than separate pretreatment.

4. The industrial surveillance branch should be prepared to take action to enforce the oil and grease and metals limitations in the revised Sewer Use Ordinance, because there will be a number of industries which discharge pollutants above these limitations. However, waivers should be granted to industries which discharge emulsified oil and grease at concentrations (less than 400 mg/l) that ensure that it will have no adverse impact on the treatment plants or on the sewers. Thus, of the industries listed on Table 3-2, oil and grease waivers should be considered for [redacted], on the condition that they pass their wastewaters through gravity oil separators. Installation and proper operation of gravity oil separators should alleviate the other expected oil and grease violations.

Industries Number 1000499, 605016, 10000498, 531590, and 604161

CHAPTER 3

CHAPTER 3

NEEDS ANALYSIS

OBJECTIVES

The primary objectives of this chapter are to assess the need for installation of joint industrial waste pretreatment facilities in Indianapolis, to reduce the cost of compliance with the revised Sewer Use Ordinance, and to reduce the impact of industrial wastes in the Combined Sewer Overflows (CSO's) on the water quality of the White River.

Initiating joint pretreatment in Indianapolis may provide a means for smaller, marginally profitable industries to economically discharge their waste into the sewer without having a detrimental impact on the Belmont and Southport Wastewater Treatment Plants. Joint pretreatment involves the consolidation of the discharges from a number of industries into one waste stream, which is then treated in a single pretreatment plant. Joint pretreatment facilities could be owned and operated by the City of Indianapolis or by industry organizations and would be less expensive than the smaller less efficiently designed an operated individual pretreatment plants which would otherwise be needed to meet ordinance limitations. To thoroughly evaluate the feasibility of such facilities and compare them with separate industry pretreatment, this chapter characterizes each industry in Indianapolis on the basis of three categories: discharge of priority pollutants, location, and size. These three categories were then used as a means of eliminating industries which either do not need joint pretreatment or are not located in an area where participation in a joint pretreatment project would be practical. Industries not eliminated were then evaluated with respect to their need for joint pretreatment, and the feasibility of locating a joint pretreatment facility in their vicinity.

Although construction of CSO's in Indianapolis ceased in 1964, the majority of the present sewers are still combined sewers. During rainstorms, many of these sewers are loaded beyond their capacity and as a result discharge untreated sewage into the White River and its tributaries. Because of this condition during storms, there is a possibility that industrial wastes in the overflow is significantly affecting the water quality of the White River. One of the most important goals of this section is to evaluate the severity of the industrial waste overflow problem, by estimating the impact of CSO's on the White River water quality, and to determine whether it is feasible to lessen mitigate the problem through joint pretreatment of industrial discharges.

CHARACTER OF INDUSTRIES REQUIRING PRETREATMENT

Potential Discharge Limit Violators

Prior to this analysis of joint pretreatment, an investigation was conducted to determine which pollutants cause impacts on the Belmont and Southport treatment plants, or which cause a decrease in water quality in the White River. It was determined that the pollutants presently causing most of the problems are the heavy metals, discharged primarily by metalplaters. It appears that there are also some concerns associated with phenol, cyanide, and oil and grease. Industrial discharge concentration limits for heavy metals and other industrial pollutants were developed in Chapter 7 of the Task 4 Report, and are presented here in Table 3-1, as they are proposed in the new Industrial Waste Ordinance. The impact of organics was found to be small in comparison to that of metals, and very little data was available documenting organics in discharges from specific industries. Therefore, the focus of this evaluation tends to be concentrated on the problems which arise as a result of an abundance of heavy metals in the sewers of Marion County.

Using as a basis the discharge limits currently proposed for in the Revised Sewer Use Ordinance (Table 3-1) and the industrial discharge pollutant concentration data generated in the Industrial Waste Survey (Task 1) earlier in this

TABLE 3-1

INDIANAPOLIS PRETREATMENT PROGRAM
INDUSTRIAL WASTE DISCHARGE LIMITS AS PROPOSED
IN THE NEW INDUSTRIAL WASTE ORDINANCE

Pollutant	Limitation
Arsenic	1.5 mg/l
Cadmium	1.0 mg/l
Chromium (total)	13.0 mg/l
Chromium (VI)	2.5 mg/l
Copper	8.0 mg/l
Cyanide (total)	10.0 mg/l
Cyanide (a)*	1.0 mg/l
Lead	20.0 mg/l
Mercury	0.05 mg/l
Nickel	5.0 mg/l
Silver	90.0 mg/l
Zinc	20.0 mg/l
Phenol	50.0 mg/l
Pentachlorophenol	12.5 µg/l
Oil and Grease	200 mg/l

*(a) means amenable to chlorination.

Pretreatment Project, each industry was evaluated separately as to which pollutants, if any, it is discharging in excess of the discharge limits. All industries which were found to exceed the limits for any pollutant were identified and subject to further analysis. The industries which did not exceed the limits were eliminated from further consideration in this report because they will not require pretreatment to meet the discharge standards. Table 3-2 provides a list of each industry requiring pretreatment together with the pollutant(s) it discharges in excess of the given limits. This group of industries is used as the basis for evaluation of joint pretreatment.

As can be seen on Table 3-2, the industries with a potential need for pretreatment can be divided into a group of metalplaters, and a group of assorted other industries. The pollutants for which preatreatment is most often needed are cyanide, nickel, cadmium, chrome, zinc, and oil and grease.

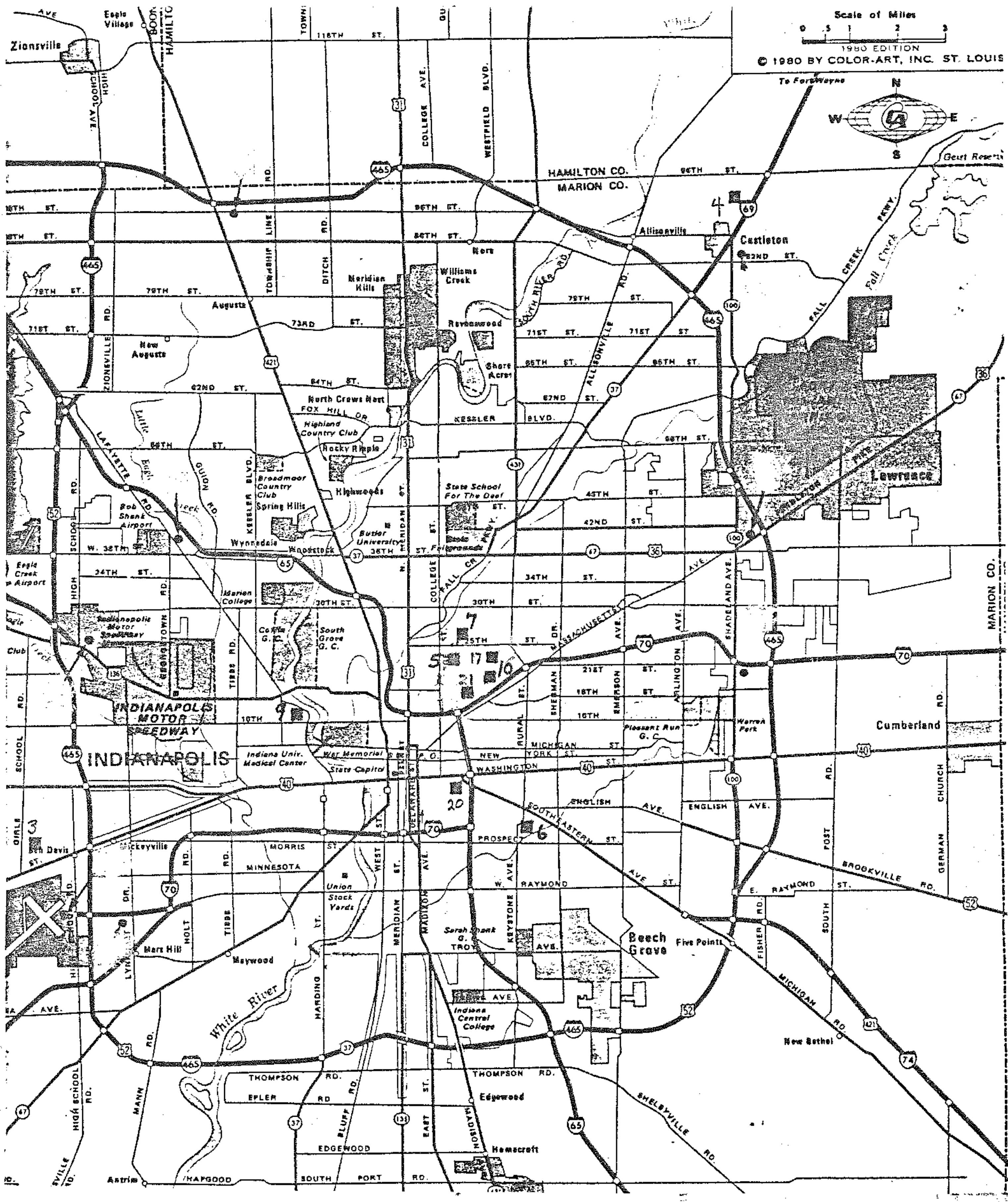
Industry Location. The economic practicality of a joint pretreatment facility requires that the industries participating in joint pretreatment be in fairly close proximity to each other. Any attempt at jointly treating wastes from industries located in widely separated neighborhoods or in different sewer drainage basins will generally be expensive due to piping and pumping costs or hauling costs. Therefore, each industry exceeding the discharge limits given in the Revised Sewer Use Ordinance was plotted on a map of Indianapolis (Figure 3-1). It was determined that one section of Indianapolis contains a high concentration of problem industries, all but one of which are metalplaters. This section, shown in Figure 3-1, is the most reasonable area for joint pretreatment with respect to industry location.

Industry Sizes. The need for joint pretreatment by any particular industry varies depending on the size of the industry. Most larger industries consider it worthwhile to operate and staff their own pretreatment facilities at the industry site. Generally, the larger industries are in a better position to finance their own pretreatment facilities than the smaller industries, and tend to prefer this approach which avoids the necessity of cooperating with competitors and also

TABLE 3-2

INDIANAPOLIS PRETREATMENT PROGRAM
INDUSTRIES IN INDIANAPOLIS EXCEEDING DISCHARGE LIMITS FOR HEAVY METALS

Industry No.	Name	No. of Employees	Pollutants Discharged Over Limits	Industry Type	Located in Concentrated Area	Map Location Code
641742	[redacted]	29	Zn	06		1
606722	[redacted]	140	OAG	16		2
10000196	[redacted]	1200	Zn	08		4
10000358	[redacted]	102	Hg	13		3
9321801	[redacted]	4	CN, Ni	09	*	5
10000134	[redacted]	395	CN	14		6
606234	[redacted]	52	Cr, CN, Ni	09	*	7
10000343	[redacted]	33	OAG	35		8
10000323	[redacted]	170	Cr, Cu, Ni	16		9
604161	[redacted]	150	OAG	35		10
1000499	[redacted]	45	OAG	3		11
605016	[redacted]	90	OAG	3		12
10000498	[redacted]	90	OAG	3		13
531590	[redacted]	51	OAG	35		14
606170	[redacted]	25	OAG	16		15
603219	[redacted]	8	CN	06	*	16
606582	[redacted]	15	Cd	09	*	17
10000599	[redacted]	110	Cd	17		18
606050	[redacted]	10	OAG	28		19
10000721	[redacted]	30	Cd, Zn	09		20
603202	[redacted]	60	Cd, Cr, CN, Zn	09	*	21



LOCATION OF INDUSTRIES EXCEEDING
DISCHARGE LIMITS IN INDIANAPOLIS

FIGURE 3-1

eliminates the need for concern over which firm may be responsible for pretreatment facility upsets. Consequently, emphasis should be placed on finding a location for a joint pretreatment facility which would benefit the largest number of small industries. Likewise, it is appropriate to eliminate large industries from further consideration of joint pretreatment due to size.

Many of the large industries in Indianapolis currently provide for their own private pretreatment. Table 3-3 lists the industries which have existing pretreatment plants. As noted above, large industries are much more likely to be financially capable of solving their own pretreatment problems than the smaller industries. Table 3-2 lists all of the industries which potentially need pretreatment and the number of employees at each one. Among this group of industries, seven have 100 or more employees. These seven are considered to be large enough that they would not consider joining a joint pretreatment project. None of these seven industries is located in the area of concentration in Figure 3-1, thus it would tend to be impractical to include them regardless of their size.

With the elimination of the above seven industries due to size and location, five of the remaining 14 industries are located in the concentrated area, which makes them good candidates to be considered for joint pretreatment. The remainder of this evaluation will focus its consideration of joint pretreatment in the area of concentration shown in Figure 3-1.

Metalplater Joint Pretreatment Needs

Table 3-2 indicates which industries are in the area of concentration and lists the number of employees together with the metals discharged over the proposed limits by each one. With the exception of Industry No 603219 [redacted], all of the industries in this area are metalplaters. The advantages of joint pretreatment for metalplaters are generally greater than for other industries for several reasons. They are as follows:

TABLE 3-3

INDIANAPOLIS PRETREATMENT PROGRAM
BACKGROUND WHITE RIVER CONCENTRATIONS,
INDIANAPOLIS POTW AVERAGE INFLUENT CONCENTRATIONS
AND PILOT AWT AVERAGE EFFLUENT CONCENTRATIONS

	Indianapolis (1) POTW Average Influent Concentration	Background White River (2) Concentration	Pilot AWT (1) Average Effluent Concentration
Cd (mg/l)	6	3	3
Cr (T) (μg/l)	79	2	4.4
Cu (μg/l)	127	6	13
Ni (μg/l)	73	10	59
Pb (μg/l)	300	18	1.5
Zn (μg/l)	455	10	225
Oil and Grease (mg/l)	57	3	2

(1) Influent and effluent concentrations were taken from Chapter 7 of the Task 4 report.

(2) Background concentrations were taken from Table 6-10 (b) of the Task 4 report.

- Most metalplaters tend to be small, and as a result it is less economical for them to build and staff their own pretreatment plant than for large industries which can take advantage of economics of scale.

- Metalplaters are generally smaller companies with limited financial resources for providing their own pretreatment.

- Metalplaters tend to locate their plants in one area of town, thus making joint pretreatment fairly practical from a standpoint of location.

- Metalplaters tend to discharge high concentrations of a limited number of metals rather than a variety of other pollutants, such as might be discharged by an organic chemicals manufacturer. This eliminates the need for "broad spectrum" pretreatment capable of removing many different for other pollutants. This implies a substantial savings in joint pretreatment costs for metalplaters as compared to any group of other industries which discharge a greater variety of pollutants.

- Metalplating wastes tend to be similar in nature and require similar waste tretment facilities.

These characteristics are common to all of the metalplaters located in the area of concentration in Figure 3-1. Furthermore, this group of metalplaters only discharges five heavy metals above the proposed limits. Considering these characteristics, it appears that this specific location is particularly well suited for joint metalplater pretreatment. It is recoganized that three of the five identified industries currently operate pretreatment facilities. However, the facilities are limited to neutralization and in some cases filtration, and apparently are not effective at reducing the concentrations of regulated pollutants. A more detailed evaluation of a joint metalplater pretreatment facility, including an analysis of the cost of joint pretreatment versus individual pretreatment, will be discussed in the Chapter 4.

Oily Waste Joint Pretreatment

As seen on Table 3-2, oily waste dischargers constitute the other major group of industries, besides metalplaters, that are expected to require pretreatment to meet the proposed industrial discharge limits. There are nine industrial facilities listed which now discharge more than 200 mg/l of oil and grease. However, unlike the metalplaters, these industries are not similar in the production processes they use, nor is the oil they discharge of a uniform quality. The oily waste dischargers include a dairy and meat by-products plant discharging highly biodegradable animal fat, three laundries discharing highly emulsified oil and grease, one printing shop and two mechanical fabrication shops probably discharging machine oils, and a drum cleaning firm which may discharge almost anything. The industries are not located close together, so wastes would have to be piped long distances to transport them to a joint facility. Part of the reason for the 200 mg/l oil and grease limit imposed by the City is the prevention of clogging and safety problems in sewers, so piping oily waste across town is not a solution to this part of the problem.

Two of the nine have more than 100 employees, and therefore are large enough that they would probably prefer to own and operate their own pretreatment facilities rather than participate in a joint project. The three laundries do not discharge more than 400 mg/l of oil and so meet the criteria suggested in Chapter 7 of the Task 4 Report for waiver of the 200 mg/l oil and grease limit, in that they do not discharge oil that could be removed in a simple gravity separator. The over-riding reason that joint pretreatment for oil removal is not practical for even the four oil dischargers remaining after elimination of the large firms and the laundries is that the oil removal standard is quite simple. All that is required is a quiescent tank with a skimmer and an operator to check periodically that the unit is functioning. The technology is os simple that the economics of scale in a joint facility are negligible. Therefore, no joint pretreatment plan is proposed for oily wastes.

Consideration has been given to the possibility of initiating some type of joint pretreatment for the oil reclaiming industries in Indianapolis. At this time, however, this possibility is fairly impractical. There are presently only two oil reclaimers in Indianapolis which have an impact on the Belmont and Southport treatment plants, and these two reclaimers are not located close enough together to make joint pretreatment economically feasible. Therefore, the remainder of this chapter does not consider oil reclaimers in its evaluation of industries requiring pretreatment.

IMPACT OF INDUSTRIAL POLLUTANTS IN CSO'S

General

At the present, Indianapolis has an approximate total of 130 active Combined Sewer Overflows (CSO's). These CSO's release combined storm drainage and sanitary sewage to the White River when stormwater overloads the capacity of the sewerage system piping. The CSO's are generally located in the central section of Indianapolis, which contains most of the combined sewers in the City, as well as most of the industrial dischargers. Sanitary sewage from outlying residential areas on the northside of town is collected in separated sanitary sewers, but flows through the combined sewer system on the way to the treatment plant. The CSO's discharge to the White River and several tributaries at points between 1/2 mile and 10 miles upstream of the Belmont Treatment Plant Outfall.

The industrial discharge limits recommended for the revised Sewer Use Ordinance in the previous Task 4 Report of this study were designed to protect the White River during low-flow conditions against impacts that could be caused by industrial pollutants passing through the Belmont and Southport Treatment Plants. Thus, these limits assumed both that pollutants would be diluted by non-industrial flows in the sewers, and that some removal would be accomplished in the treatment plant. Neither of these assumptions is valid if an industry is responsible for discharging a large proportion of the flow to a specific sewer lateral or main which overflows to the river through a CSO just downstream on the sewer system from the industry. On the other hand, CSO events generally occur during wet weather when the river flow rate is quite high, resulting in a reduction in pollutant concentration due to dilution. The purpose of this analysis is to determine whether there is evidence of risk to the White River due to industrial pollutants in CSO's based on available data.

The majority of the data used for this evaluation was taken from a study done by Howard, Needles, Tammen and Bergendoff (HNTB) which addresses the impact of CSO's on White River water quality at Indianapolis. HNTB's study included collection of river and/or CSO flow data and pollutant concentration data for several storms occurring in Indianapolis in 1981. Of these storms, five were selected for which both CSO and river flow data were available, and an evaluation made on the basis of these storms.

Out of the 130 active CSO's in Indianapolis, HNTB monitored 30. Moreover, for any particular storm, data was collected from only a fraction of these. Consequently, the calculations in this report involving the flow from all CSO's as a group are based on the available HNTB data for certain specific CSO's, extrapolated up on the assumption that the other CSO's would generate similar results.

The pollutants considered in this analysis are the heavy metals listed in Table 3-3 and oil and grease. These were the only industrial or priority pollutants measured by HNTB during their study. Other pollutants not measured by HNTB, such as cyanide, could be substantially affecting the White River water quality. Since no CSO data was available, they could not be evaluated in this analysis, but it is expected that their impacts will be mitigated by dilution to the same extent as those of the pollutants that are analyzed.

The evaluation of the overflow problem was approached in two ways:

1. All CSO's were considered as one single composite discharge, and their affect on the White River evaluated as a whole. An estimate of the ratio of total CSO flow to river flow was made for each storm, and from this an estimate of the resulting concentrations of pollutants in the White River was obtained.

2. Each CSO was put into a group based on its location and the impact of individual CSO's was evaluated separately. The groups (shown in Table 3-4) were established by HNTB because many of the CSO's are so close together that it was nearly impossible to monitor each one individually. The concentrations of pollutants in each monitored CSO were compared with the EPA and Fathead acute criteria in order to determine whether any particular CSO is discharging unusually high concentrations of pollutants. The relationship between location of these CSO's and location of industry was examined.

Based upon this evaluation of composite CSO impact and localized CSO impact, a determination was made as to whether CSO's contribute significantly in decreasing the water quality of the White River during storms.

Composite CSO Impact

Calculation of CSO-River Flow Ratio. In order to determine the change in concentration of pollutants in the White River caused by total overflow from all 130 CSO's, an estimate of the ratio of total overflow to river flow was obtained for each storm. Table 3-5 shows White River flow data taken by HNTB at three different sampling stations. The stations are shown in Figure 3-2. This data was used as a basis for determining the three river flow rates used in Table 3-6, which shows the computed ratios of CSO to River flow, using river flow values of 300 cfs, 700 cfs, and 1,000 cfs. These selected river flow rates are assumed to be representative of White River flow rates occurring during three different storm situations.

TABLE 3-4

INDIANAPOLIS PRETREATMENT PROGRAM
HNTB CSO GROUPS

	Pleasant Run Creek Groups							
	1	2	3	4	5	6	7	8
CSO's Included	089, 090*, 091, 092, 134	083, 084*, 085, 086, 087, 088, 154	079, 080, 081, 082,	075, 076, 077*, 078	074	026, 027, 030, 031, 106, 107*, 127	015,016, 017,018, 019,020, 021,022, 023*,025, 119*,148, 149,150, 151	120*,130

	Fall Creek Groups						
	1	2	3	4	5	6	7
CSO's Included	135, 146,	061, 063, 063A, 064, 065*, 066, 141*, 142*, 144, 155, 156	062*	052*, 053, 054*, 055, 056, 057, 058, 059, 063A, 131, 132	051, 060*,	050, 050A*,	049

	Pogue's Run Groups			
	1	2	3	4
CSO's Included	102, 143,	035, 036, 095, 096, 097, 198, 099, 100*,	034*, 101, 133*, 136 137, 138 138A, 152	115*, 116, 125, 128, 129*, 153,

	White River Groups			Eagle Creek Groups	
	1	2	3	1	2
CSO's Included	042, 043*, 045*, 046	037*, 038, 039*, 040, 041, 147	012, 013*, 014, 117, 118*, 118A, 121, 122, 123	032,033	011*,145

*Indicates HNTB-monitored CSO.

TABLE 3-5

INDIANAPOLIS PRETREATMENT PROGRAM
PEAK AND MINIMUM WHITE RIVER FLOWS MEASURED BY HNTB FOR SEVERAL STORMS

	82nd St. (WR1)		Morris St. (WR4)		Southport Rd. (WR5)	
Storm Date	Min. Flow Before Storm (cfs)	Peak Flow During Storm	Min. Flow Before Storm (cfs)	Peak Flow During Storm	Min. Flow Before Storm (cfs)	Peak Flow During Storm
7/18	--	--	--	--	--	--
8/5	623	1,798	--	1,839	--	2,913
8/10*	593	611	571	610	1,495	1,596
8/27	—	—	—	—	—	—
8/30	—	—	742	2,298	—	3,956

*Hourly flow data for this particular storm was not available. These values are minimum and peak values given by HNTB, but measurements may not have been taken throughout the entire storm. Therefore, these values may not be truly representative of actual minimum and peak flows during this storm.

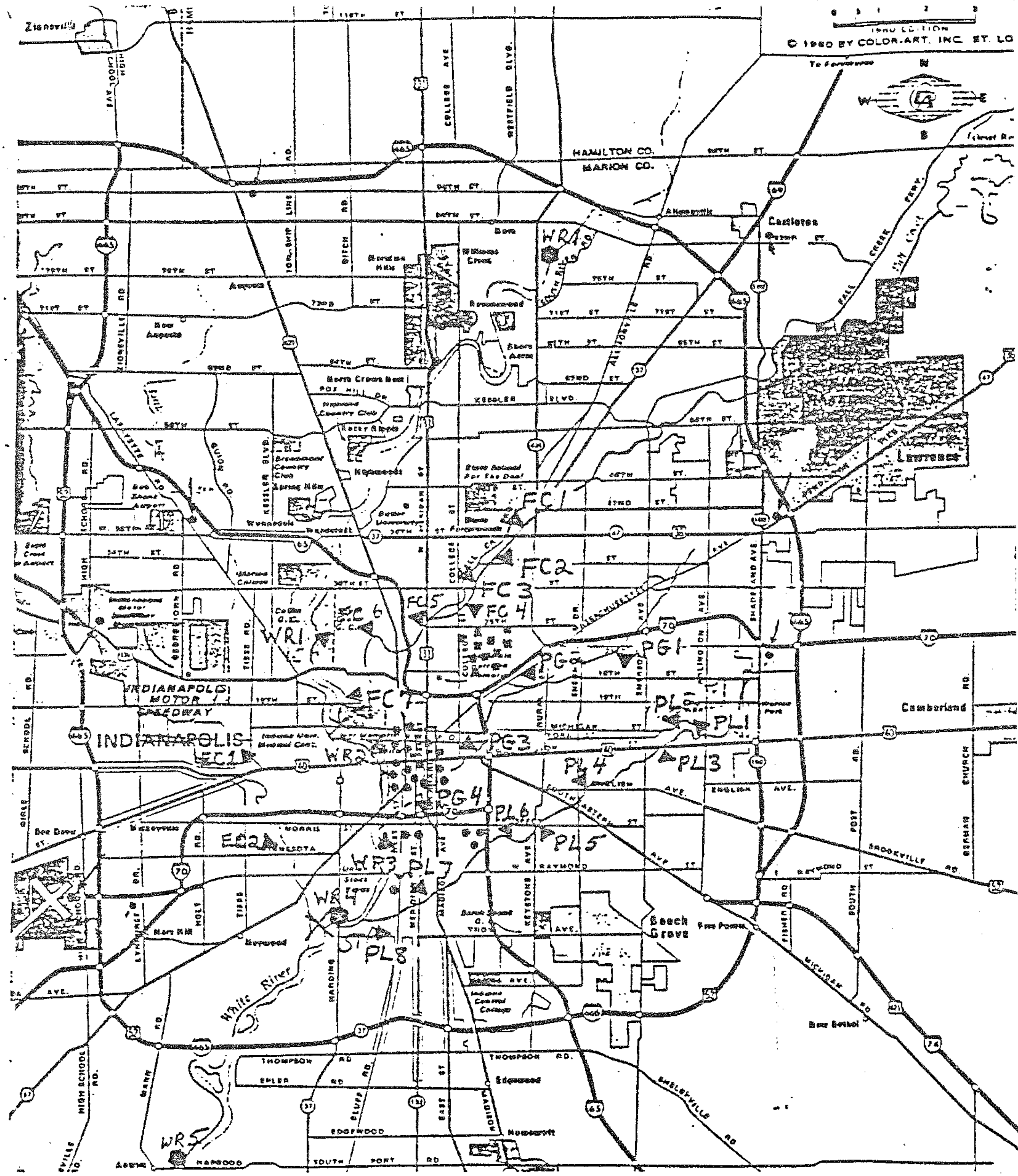
TABLE 3-6

INDIANAPOLIS PRETREATMENT PROGRAM
CSO-RIVER FLOW RATIOS AND RESULTING WHITE RIVER CONCENTRATIONS DUE TO CSO'S

Storm Date		July 18			August 5			August 10			August 27			August 30		
White River Flow Rate		300 cfs	700 cfs	1,000 cfs	300 cfs	700 cfs	1,000 cfs	300 cfs	700 cfs	1,000 cfs	300 cfs	700 cfs	1,000 cfs	300 cfs	700 cfs	1,000 cfs
Ratio of Average Total CSO Flow Rate to River Flow(1)		1:4	1:6	1:8	1:5	1:7	1:9	3:7	1:3	1:4	3:7	1:3	1:4	3:5	1:2	2:5
Ratio of Peak Total CSO Flow Rate to River Flow		1:3	1:4	1:5	1:3	1:4	1:5	1:2	3:7	1:3	1:2	2:5	1:3	7:9	2:3	3:5
Resulting White River Concentrations Due to Overflow and Indy POTW Effluent (Belmont & Southport) (μg/l)(2)																
Cd	average	--	--	--	90	65	52	10	9	7	--	--	--	7	--	--
	peak	--	--	--	148	112	90	12	10	9	--	--	--	8	8	7
Cr	average	--	--	--	--	--	--	--	--	--	--	--	--	61	--	--
	peak	--	--	--	--	--	--	--	--	--	--	--	--	78	--	--
Cu	average	--	--	--	88	64	51	96	75	58	104	82	63	135	114	93
	peak	--	--	--	140	106	88	110	96	75	120	97	82	173	150	135
Ni	average	--	--	--	--	--	--	138	--	--	--	--	--	--	--	--
	peak	--	--	-	-	--	--	160	--	--	--	--	--	--	--	--
Pb	average	--	--	--	--	--	--	--	--	--	263	--	--	304	--	--
	peak	--	--	--	--	--	--	--	-	--	305	--	--	391	--	--
Zn	average	--	--	--	262	--	--	--	--	--	--	--	--	--	--	--
	peak	--	--	--	360	--	--	--	--	--	--	--	--	--	--	--
O&G	average	--	--	--	6,100	5,300	4,800	12,000	9,800	8,100	--	--	--	18,000	15,000	13,000
	peak	--	--	--	8,600	7,200	6,100	13,000	12,000	9,800	--	--	--	22,000	20,000	18,000

((1) Explanations of CSO flow rates are given in Table 3-4. The final river flow rate used in computing the ratio is the given flow rate added to the average flow rate from the Belmont and Southport treatment plants (291 cfs).
(2) Indianapolis POTW effluent concentrations are given in Table 3-3.

NOTE: Except for the storm on July 18 for which no pollutant concentrations were measured, dashes indicate concentrations below EPA and Fathead criteria, not unmeasured values.



LOCATION OF CSO GROUPS AND AREAS OF CONCENTRATED INDUSTRY IN INDIANAPOLIS

FIGURE 3-2

- AREA OF CONCENTRATED METALPLATERS

- OTHER AREAS OF CONCENTRATED INDUSTRY

- HNTB River sampling station

The first flow rate (300 cfs) is a relatively low flow rate approximately and would occur during dry weather. Therefore, if overflow were to occur, the impact of pollutants would be the greatest for this flow. This situation is assumed to be an extreme case, in that the occurance of a fairly large storm during a period of dry weather and low river flow is not very likely. The second flow rate (700 cfs) is representative of a typical wet period just prior to a storm. Overflow events often start under these conditions. The third flow rate (1,000 cfs) would occur after the beginning of a storm and would most likely be accompanied by significant combined sewer overflow. It is representative of a frequent storm event in which the River flow rate has risen in response to rainfall. Note that per the Task 15 White River Water Quality Report, average flow conditions in the White River result in a flow of 2,000 cfs.

Concentrations of Pollutants in Composite CSO Flow. To estimate the magnitude of the composite CSO problem, the concentrations of pollutants in the total CSO flow (Table 3-7) were compared with the EPA Acute Water Quality Criteria and Fathead LC-50 toxicity levels (Table 3-8). All pollutants with concentrations less than these criteria were excluded from further evaluation on the basis that they would be diluted to even lower concentrations upon entering the river, and would not pose a serious threat to the White River water quality. The remaining pollutants, present in concentrations above the EPA and Fathead criteria, were then evaluated individually for each storm as to what their impact on the White River water quality would be.

Table 3-6 gives the resulting concentrations of pollutants in the White River assuming the given White River flow rates and CSO-river flow ratios. Also used in computing these concentrations are the White River background concentrations given in Table 3-3. Concentrations are listed on Table 3-6 for all pollutant and storm situations which result in river concentrations above the EPA acute criteria or the (0.1) LC-50 Fathead value. In addition, the highest calculated concentration is listed for each pollutant for which no storm events resulted in concentrations above the water quality criteria.

TABLE 3-7

INDIANAPOLIS PRETREATMENT PROGRAM
TOTAL CSO FLOWS AND CONCENTRATIONS FOR SEVERAL HNTB MONITORED STORMS

	7/18	8/5	8/10	8/27	8/30
No. of CSO's for which Data was Available	16(5)	5	8	5	15
Rainfall (in)	0.4	0.31	0.22	0.4	1.06
Total Overflow (ft^3)(1)	5,031,000	1,445,000	1,698,000	2,102,000	22,220,000
CSO Event Duration (hr) (2)	1.75	3.75	1.8	2.0	5.3
Average Total CSO(3) Flow Rate (cfs)	200	167	459	442	877
Peak Total CSO(4) Flow Rate (cfs)	295	358	750	696	1,962
Cd(μg/l)	—	440(6)	20	10	10
Cr (T) (μg/l)	—	150	30	100	100
Cu(μg/l)	—	400	210	230	220
Ni (μg/l)	—	120	310	90	65
Pb (μg/l)	—	390	150	600	500
Zn (μg/l)	—	850	710	490	540
O&G (mg/l)	—	20.7	24	3.5	28

(1) Total overflow was computed by adding all overflows measured at HNTB-monitored CSO's, dividing by the number of monitored CSO's, and multiplying by the total number (130) of CSO's.

(2) CSO event duration is assumed to be equal to the average number of hourly flow readings per event which was computed by adding up the number of hours for which readings were taken at each monitored CSO and then dividing by the number of monitored CSO's.

(3) Average total CSO flow rate was computed by summing the average flow rates for the CSO's monitored, dividied by the number of monitored CSO's, and multiplying by the total number (130) of CSO's. Note that the average flow rate for each monitored CSO was calculated by summing all of the instantaneous flow readings for that CSO and dividing by the number of flow readings.

(4) Peak total CSO flow rate was computed by summing the peak flow rates for all HNTB-monitored CSO's, dividing by the number of monitored CSO's, and multiplying by the total number (130) of CSO's.

(5) Out of these 16 CSO's, flow rates were given for only three. No concentration measurements were given.

(6) Note that all concentrations are average concentrations computed by multiplying each individual CSO concentration measured by HNTB by the flow from that CSO, adding these numbers for all monitored CSO's from each particular storm, and then dividing by the total amount of flow from all of these same CSO's.

As can be seen by comparison of Tables 3-6 and 3-8, none of the storm conditions investigated resulted in river concentrations exceeding either the EPA acute or (0.1) LC-500 Fathead water quality criteria for chrome, nickel, lead, or zinc. It should be noted that the measured total chrome concentrations are assumed to be mainly trivalent chrome. If the chrome were in the hexavalent form, river concentrations would be found to exceed the EPA acute criteria, although they would not exceed the fathead criteria. The assumption that the chrome is not in hexavalent form is supported by the fact that while the Belmont influent total chrome levels were found to average 79 μg/l, the hexavalent chrome concentration was below the 10 μg/l detection limit. Therefore, it can be concluded that current discharge levels of chrome, nickel, lead, and zinc do not pose a hazard to the White River after complete dilution of all CSO flows in the river.

The cadmium concentration calculated to result from CSO discharges all fell above the EPA acute criteria, but below the Fathead criteria. The large difference between the EPA acute and Fathead criteria indicates that the EPA criteria may be based upon toxicity to organisms far more sensitive than those that are important and indigenous to the White River. As in the case of the development of the proposed industrial discharge limits in Chapter 7 of the Task 4 Report (Pilot Plant Results), the Fathead criteria is the appropriate criteria to apply in this case, so the calculated cadmium concentrations do not exceed applicable water quality criteria.

Consideration of two other factors also tends to indicate that cadmium in CSO's should not be a problem in the future. The first is the fact that while JMM employed an analytical technique with a detection limit of 2-3 μg/l for cadmium, HNTB employed a technique with a 10 μg/l detection limit. Thus, most of the cadmium data collected for CSO's can be interpreted as having identified some cadmium at or below detection limit. Essentially, values for cadmium between 2 and 10 should be taken to be equivalent. This means that compliance with the EPA acute criteria cannot be demonstrated using the analytical technology employed in the HNTB CSO study, and thus basing a

TABLE 3-8

INDIANAPOLIS PRETREATMENT PROGRAM
INDUSTRIAL POLLUTANT CONCENTRATION LIMITATIONS APPLICABLE
FOR CSO DISCHARGES TO THE WHITE RIVER

Pollutant	Concentration Limit (µg/l) Fathead LC-50 * 0.1	EPA Acute Criteria
Arsenic	1,566	440
Cadmium	718	7
Chromium (total)	2,800	11,000
Chromium (VI)	4,400	21
Copper	52	48
Cyanide (a)	11.25	47 [a]
Cyanide (total)	136 [a]	567 [a]
Lead	12,400 [c]	460
Mercury	15	4
Nickel	2,700	3,400
Silver	8.8	16
Zinc	1,580	630
Phenols	3,907	10,200
Oil & Grease	5,000 [b]	--

(a) Note that the sum of free amenable cyanide and the cyanide liberated through photodegraduation of ferrocyanide equals the total river concentration, per Chapter 7 of the Task 4 Report.

(b) Oil and grease limit is set at level which will cause surface film

(c) Average of data for static tests with hardness 20 to 360 µg/l.

standard on the EPA criteria is not practical. Also, the cadmium concentrations measured in all of the storms, except that on 8/5/81, should be considered to be equivalent to sewage background. The second consideration is that the concentration of cadmium measured in CSO 043 on 8/5/81 (800 μg/l) is very close to the proposed discharge limit for this compound.

The flow volume for CSO 43 during the 9/5 storm was 167,000 gallons, and it occurred over a period of about 4 hours, which is equivalent to a flowrate of 700 gpm or 1 mgd. Because there are very few industries discharging at this flowrate and none are likely to be discharging cadmium, it is unlikely that the 800 u, g/l concentration in the overflow is due to an 800 to 1,000 u, g/l concentration in an industrial discharge. Therefore, either there was a discharge of cadmium above the discharge limit, or the stormwater scoured out a deposit of cadmium from the sewer that could have been deposited over a long period of time. HNTB found evidence of the "first flush" phenomrnon during the 8/5/83 storm, in which high concentrations are measured early in a CSO event as sewer deposits are flushed out, with low concentrations at the end of the event. This is illustrated by Figure 5.3 in Appendix B, excerpted from the HNTB report.

If the cadmium resulted from a slug discharge of highly concentrated industrial waste, effective enforcement of the proposed 1,000 μg/l cadmium limit will prevent recurrence in the future. If, on the other hand, cadmium was associated with solids deposits flushed out of the sewer, then it is probably not present as dissolved cadmium and would consequently pose no toxicity hazard in the river. It would simply settle out with the sediment in the river. In any case, the available data for cadmium impact on the river following full dilution does not indicate that the industrial discharge limit should be reduced from 1,000 μg/l, or that any facilities should be constructed to prevent CSO discharges in general.

The copper concentrations calculated for practically all of the storm situations exceeded both the (0.1) LC-50 Fathead and EPA acute criteria. The measured CSO copper concentrations ranged from less than 10 μg/l up to 2,200 μg/l, with most values falling between 200 and 400. Concentrations in this range were found in practically all of the CSO's, indicating that the copper comes from numerous low-level sources throughout the City, rather than a few large dischargers.

In light of the fact that the background concentration of copper in domestic sewage in Indianapolis is approximately 100 µg/l, much of theCSO copper may not be related to industrial discharges. A concentration of 270 µg/l copper was measured in Indianapolis drinking water during the pretreatment pilot plant experiments in the spring of 1982 and was attributed to the use of copper sulfate to control biological activity in the drinking water distribution system. The fact that the copper concentrations measured even for large (well diluted) CSO flows were well above the 130 µg/l average copper in the influent to the Belfmont and Southport treatment plants indicates that the CSO copper is associated with solids deposits. Consequently, it probably poses no toxicity hazard in the river, since it is in insoluble form. Nevertheless, CSO events now cause and will continue to cause theoretical river concentrations in excess of both the Fathead and EPA acute criteria. While reduction of industrial discharges by setting ordinance limits and requiring pretreatment will reduce the peak copper levels, domestic sewage contains enough copper to exceed the water quality standards. This is because of the tendency for copper to precipitate and settle out into sewer solids deposits, which are then flushed out by CSO's. A reduction in the total CSO flow by at least a factor of 10 would be required to meet the water quality criteria.

As in the case of copper, the calculated river concentrations for oil and grease exceed the 5 mg/l water quality criteria assume dto apply in the White River. However, the 5 mg/l criteria is set to prevent a visible oil film rather than on the basis of toxicity to aquatic life. Thus, this is not as rigid a standard as those set for toxic compounds. The oil and grease concentrations detected in the CSO flows generally fell within the 25-50 mg/l range typical for domestic sewage. Three measurements were made of oil and grease above 100 mg/l, which indicates that discharges are going to the sewer without being treated in a gravity separator (grease trap or API separator). It is likely, however, that high oil and grease levels may be due to leaking tanks or low volume gas station (or home auto maintenance) discharges and not industrial process discharges. As with heavy metals, oil accumulates in sediment deposits and is flushed out during CSO events with the solids. Oil attached to solids does not form a surface film, and it has been found to be relatively biodegradable. Thus, although the oil from CSO's results in river concentrations above the 5 mg/l criteria selected for prevention of a visible surface film, there is no strong evidence that it poses a significant threat to the aquatic life in the river if short-term concentration rise to 25 mg/l during storm events.

In summary, CSOO discharges of cadmium, copper, and oil and grease can cause concentrations in the White River which exceed one or more of the proposed water quality criteria. However, because the discharges appear to be due to long-term accumulation of these materials in sewer sediment deposits which are flushed out through CSO's, and becuase industrial process discharges are probably not the major sources of these materials, pretreatment will not be effective in reducing the discharges to below the water quality criteria. Partial or complete elimination of CSO events through flow storage would provide a reliable means of eliminating the risk of river impact. However, because the pollutants in question are tied to the solids, the actual risk of impact is relatively small and probably not great enough to justify the large expense required to eliminate CSO's.

Localized CSO Impact

General. While the above analysis evaluates the effect on the entire White River after full dilution of the CSO flows, it does not determine whether there are localized problem areas in which concentrated industrial waste from a few CSO's may constitute a disproportionately large share of the overall industrial pollutant load from CSO's. If this is the case, relatively inexpensive measures aimed at correcting selected CSO problems may significantly improve river water quality, particularly close to the problem CSO's. Therefore, the following analysis is performed to see if high industrial pollutant concentrations in CSO's correlate with the presence of industrial discharges to sewer lines tributary to the CSO.

Individual CSO's Discharging High Concentrations of Pollutants. Table 3-9 lists seven individual CSO's determined to be discharging significantly higher concentrations of pollutants than other CSO's monitored by HNTB. Also listed are the number of electroplaters and other process dischargers discharging waste into the sewers tributary to these CSO's. Each CSO is listed with its respective group assigned by HNTB. The locations of the groups are shown in Figure 3-2.

The three CSO's with the largest overflows (115, 118, 120) are each located downstream of many industries, and in particular, metalplaters. High pollutant concentrations of these CSO's could be caused by accumulation of discharge from these industries as the flow moves toward the Belmont treatment plant. The high pollutant concentrations of the CSO's with smaller overflows could be caused by one or two industries discharging directly into sewers close to the CSO's. It is possible, therefore, that there is a correlation between CSO location relative to industry and the concentration of pollutants in individual CSO's. If this is the case, increased pretreatment of pollutants in the metalplating industry could substantially reduce the concentrations of pollutants in both the total combined sewer overflow and in individual CSO's.

As can be seen by inspection of Table 3-9, there is some evidence of localized highly concentrated industrial waste discharges from CSO's. The best example is the 11,000 µg/l chrome discharge from CSO 120 on 8/10/83. This discharge would be toxic to Fatheads and other aquatic life at the point of discharge. The high chrome level was accompanied by high zinc and nickel, indicating that it is not simply an analytical abornmality. The flow rate for this CSO event was approximately 3.5 cfs, which, when mixed into the river at summer low flow (300 cfs) would result in a dilution factor of about 80 to 1, and a river concentration of 132 µg/l which would cause no toxicity problems. From a very localized point of view, CSO 120 discharges to Pleasant Run about one half mile above the junction where this tributary stream joins the White River. Flows measured in Pleasant Run during the CSO study ranged between 13.0 and 610 cfs depending on weather conditions and overflows from other CSO's upstream on Pleasant Run. On 8/10/83, the flow was between 15 and 30 cfs, which would

TABLE 3-9

INDIANAPOLIS PRETREATMENT PROGRAM
CSO'S DISCHARGING HIGH CONCENTRATIONS OF HEAVY METALS
AND POSSIBLE INDUSTRIES AFFECTING CONCENTRATIONS

CSO No.	Storm Date	Overflow (ft^3)	Inorganic Pollutant Concentration (µg/l)						O&G (mg/l)	Number of Tributary Industries	
			Cd	Cr	Cu	Ni	Pb	Zn		Metal-Platers	Other Process Dischargers
43 (b) (WR1)	8/5	22,300	800	80	300	80	170	570	41.1	1	8
60 (FC5)	8/30	2,100	15	70	380	80	920	1,450	107.0	1	0
115 (PG4)	8/27	22,000	10	240	530	120	800	800	8.0	10	48
	8/30	354,000	20	320	680	120	450	1,400	31.7		
118 (c) (WR3)	8/30	108,000	10	70	300	80	1,800	820	15.0	12	65
120 (PL8)	8/10	13,000	60	11,000 (a)	630	2,200	460	4,100	395.0	6	39
	8/30	133,000	20	620	280	480	190	830	112.0		
141 (FC2)	8/5	200	400	320	2,200	320	1,000	2,200	58.0	2	7
	8/30	342,000	<10	<10	<10	<10	<10	<10	16.0		
142 (FC2)	8/5	24,600	230	220	520	160	610	1,200	3.9	1	4
	8/30	1,184,492	10	10	110	10	90	230	27.0		

(a) As compared with other readings, this concentration is unusually high and may be attributed to a highly concentrated discharge of Cr or an error during data collection.

(b) CSO 60 is in a sewer tributary to CSO 43. Thus, all industries tributary to CSO 60 are also tributary to CSO 43.

(c) CSO 115 is in a sewer tributary to CSO 118.

have provided perhaps as little as 5 to 1 dilution. Thus, chrome concentrations of up to 2,200 µg/l may have occurred over a half-mile reach of Pleasant Run, but even this concentration does not exceed either the (0.1) LC-50 Fathead criteria or the EPA acute criteria.

A second example of localized high concentrations due to CSO's occurred on 8/5/81, when relatively high cadmium concentrations were measured in CSO's 43, 141, and 142. The measurement of high cadmium in CSO's 141 and 142 at the same time is not surprising because they are interconnected. However, CSO 43 is isolated from 141 and 143, so the high cadmium measured there is coincidental. The one electroplater in the sewer system tributary to CSO 43 is also tributary to CSO 60, which showed no high cadmium during the 8/5/81 storm. Therefore, this industry is probably not responsible for the cadmium. None of the cadmium levels in the CSO's is high enough (the highest is 800 µg/l) to result in even a localized concentration in the White River or a tributary in excess of the (0.1) LC-50 Fathead criteria (718 µg/l), because each CSO discharge is diluted at least 2 to 1 into other flow. As discussed above, the EPA acute criteria for cadmium is not an appropriate or practical standard for the White River, because it is based on data for trout and salmon in low hardness water.

These two example cases illustrate that while localized high pollutant concentrations do occur due to CSO's, they do not exceed applicable water quality criteria. Moreover, the CSO concentrations are almost equal to the proposed limits for industrial waste discharges to the sewers, indicating that the high CSO concentrations are probably due to industrial slug discharges over the proposed limits, if they are not due to flushing of accumulated solids. Thus, enforcement of the proposed limits will reduce CSO metals concentrations from those observed in the CSO study. There does not appear to be a need for CSO correction facilities to avoid discharge to the river of pretreatable industrial pollutants.

CHAPTER 4

CHAPTER 4

JOINT METALPLATER PRETREATMENT

GENERAL PROBLEM SUMMARY AND OBJECTIVES

Industries Requiring Pretreatment

In Chapter 3 of this report, the list of industries which will probably discharge concentrations in excess of the proposes ordinance discharge limitations was screened to identify the most likely candidates for joint pretreatment. Table 4-1 presents a list of five metalplater industries located in relatively close proximity to each other of appropriate size and nature to be logical participants in a joint pretreatment project. All of these industries are metalplaters located just east of Fall Creek in the vicinity of Douglas Park and Golf Course in North Central Indianapolis. Each of the five candidate industries discharges one or more of the following five priority pollutants at concentrations above the proposed ordinance discharge limitation: Cyanide, Cadmium, Chrome, Nickel, and Zinc.

Approach

The approach taken in this chapter to evaluation of joint metalplater pretreatment includes the following major steps: Process selection, conceptual design, and cost analysis. The process selection will compare the various alternative processes used for treatment of metalplater wastes and determine their applicability to particular wastes discharged by the five specific industries. The processes will be screened based on feasibility and other technical aspects, and a single most probable best alternative process train will be selected. Using the flow and concentration data available from the industrial waste survey as well as from general electroplater literature, a conceptual design for this best process train alternative will be developed. Conceptual design will include

TABLE 4-1

INDIANAPOLIS PRETREATMENT

FLOWS FOR INDUSTRIES INCLUDED IN JOINT PRETREATMENT

Industry Number	Industry Name	Total Flow (gpd)	Hex Chrome Waste (gpd)	CN Waste (gpd)	General Metals Waste (gpd)
9321801	[redacted]	1,900	0	1,900	0
606234	[redacted]	26,500	5,000	3,000	18,500
603219	[redacted]	4,700	0	4,700	0
606582	[redacted]	3,950	0	0	3,950
603202	[redacted]	89,252	10,000	8,000	71,242
	TOTALS	126,302	15,000	17,600	93,702

preliminary sizing of major tankage, as well as a list of major equipment. The conceptual design will form the basis for a preliminary cost estimate which would be developed from cost curves and the costs for similar projects recently performed by James Montgomery. In order to assess the impact of joint metalplater pretreatment in Indianapolis in comparison to individual pretreatment by each industry, an estimate will be prepared of the cost for pretreatment by each industry on its own plant site. In general, the processes utilized will be similar or identical to those in the joint pretreatment plant. The major differences will be in tankage sizing, as well as in a reduced amount of piping required to move wastes from the source to the treatment plant. The comparison of the joint versus separate pretreatment costs forms the basis for the recommended City action regarding joint pretreatment.

PROCESS SELECTION

Available Treatment Technology

In general, electroplating wastes are normally treated for removal of metal pollutants by precipitation, coagulation, and sedimentation of the metals as an alkaline sludge. Ion exchange, evaporation, freeze concentration, reverse osmosis, dialysis, and other treatment technologies are sometimes used particularly when recovery of a specific metal is economical. For example, silver is generally recovered rather than being discharged to City sewers. However, each of these processes tends to be more expensive than precipitation and sedimentation, and it is also more susceptible to interferences when wastewaters from more than one source are mixed. Consequently, while these more expensive technologies are appropriate at the source of a particular plating waste, precipitation, coagulation, and sedimentation is the process of choice for mixed metalplater wastes.

There are two wastes that require specific pretreatment prior to being treated by precipitation and sedimentation. These are wastes containing hexavalent chrome and wastes containing cyanide. Hexavalent chrome must be converted to the trivalent chrome form in order that it be precipitated. This is accomplished by reaction with sulfur dioxide under acidic conditions. Cyanide reacts to complex heavy metals and prevent their precipitation in treatment plants. Consequently, cyanide should be removed prior to the precipitation process. Cyanide is most economically removed by reaction with chlorine under alkaline conditions.

Waste segregation is obviously required in order to separately reduce hexavalent chrome, oxidize cyanide, and precipitate other metalic pollutants. Thus, each industry involved in the joint pretreatment project is assumed to segregate its wastes into one or more of the following three categories: hexavalent chrome waste, cyanide waste, general metals waste. It should be assumed that the general metals waste may be either highly acidic or highly alkali, depending on the metalplater conditions. While an acid waste is more common, alkali wastes may result from in-house neutralization and metals recovery efforts.

Precipitation and coagulation are accomplished by raising the pH of the wastewater solution through the addition of lime ($C_a(OH)_2$) or caustic soda (NaOH). Caustic is often the chemical of choice for small systems, because of ease of handling and small volume. On the other hand, lime is more often chosen for large systems because of its lower cost. It is assumed in this analysis that caustic is the chemical of choice. In some installations, polymers or other coagulant aids are used in addition to the primary coagulant. This is done to solve specific solids settling problems. It is assumed in this analysis that such chemicals will not be needed in the joint pretreatment facility under normal circumstances. However, equipment for their addition will be provided.

Sludge handling and disposal are a major problem for treatment systems handling metalplater wastes, because the sludge is often considered a hazardous material. It is assumed in this analysis that a suitable landfill can be located that will accept the sludge for disposal if dewatered to 20 percent solids. While centrifuges and vacuum filters can be used to achieve this solids concentration, filter presses of either the belt or plate and frame type have proved to be the most reliable solids dewatering devices now on the market.

Process Flow Scheme

The process flow scheme selected for the Indianapolis Joint Metalplater Wastewater Pretreatment Facility consists of a chromium reduction process in parallel with a cyanide oxidation process, with the effluent from both processes joining a general metals wastewater stream in the neutralization and precipitation process unit. The effluent from neutralization and precipitation flows to a clarifier in which sludge is removed from the wastewater. The clarified wastewater is discharged to the City sewers, while the sludge from the clarifier is pumped to a thickener. Thickened sludge is processed through a sludge dewatering filter press and loaded into trucks for disposal, while the thickener overflow water is pumped back into the neutralization and precipitation tank. This process flow scheme will be illustrated in detail in the section below which presents the conceptual design for the joint pretreatment facility. The facility will be designed for a flow of 126,000 gpd. This is the sum of the flows from the five industries which will contribute to the plant. Table 4-1 lists each of the industries, its total flow, and the flow expected for each of the three categories of wastewater. For example, Industry 603202 [redacted] is expected to contribute approximately 10,000 gpd of hexavalent chrome waste, 8,000 gpd of cyanide waste, with the remainder of its waste stream (71,252 gpd) falling into the general metals removal category. As can be seen on Table 4-1, the chromium reduction system will be designed for a total of 15,000 gpd, the cyanide oxidation system would be designed for a flow of 17,600 gpd, while the general metals neutralization and precipitation system must be designed to handle the entire 126,000 gpd of flow. Because most of the flow for the plant does come from Industry 603202 [redacted], it is logical that the location for the joint pretreatment facility should be close to [redacted] 603202. This will reduce the cost of the three pipelines which must be run from [redacted] (603202 to the facility. It can be seen on Table 4-1 that of the five industries to be included in the joint pretreatment project, three discharge a single type of wastewater. These industries will thus not require any flow segregation modifications to be made to their production facilities upstream of the point at which they discharge to the joint pretreatment facility. However, the two larger facilities [redacted] must both implement flow segregation within their production facilities. Both of these industries must run three pipelines to the joint pretreatment facility. While the cost of the three pipelines will be included in the cost estimates developed later in this chapter, the cost of flow segregation is assumed to be required whether pretreatment is by joint or separate facilities. Therefore, no estimate is made of the cost for segregation of flows within the production facility.

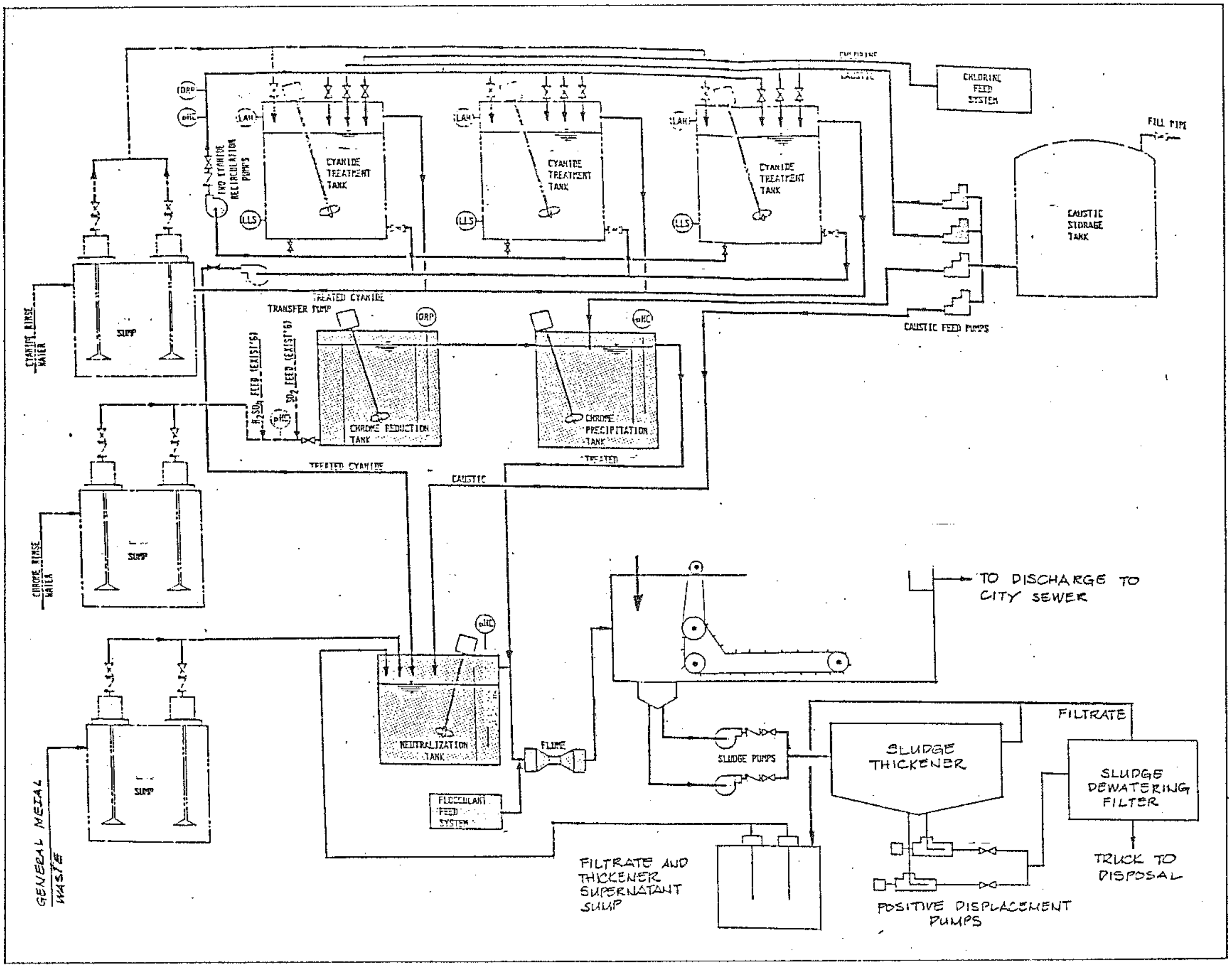
CONCEPTUAL JOINT PRETREATMENT DESIGN

Joint Pretreatment Process Flow Diagram

The process flow diagram for the proposed joint pretreatment facility is presented in Figure 4-1. The diagram shows the pipes, tanks, mixers, and chemical feed equipment that will be required to implement the design process flow scheme developed in the previous process selection section. The chromium reduction treatment process reduces hexavalent chrome to trivalent chrome by reaction with SO_2 at a pH between 2.0 and 3.0. Pipelines contributing flow to this process run from City Plating Company and Williamson Polishing and Plating.

The cyanide oxidation process oxidizes CN to carbon dioxide and nitrogen by reaction with chlorine gas. This oxidation takes place in two stages, the first converting cyanide to cyanate, and the second converting the cyanate to carbondioxide and nitrogen. The first stage oxidation proceeds most rapidly at a pH between 9 and 11, while the second stage is most efficient at a pH of approximately 8.5. Consequently, a two-stage tank system is used for the cyanide oxidation.

The metals in the general metals waste, as well as the treated chrome and cyanide wastes, are precipitated by adjustment of the pH to the point of minimum solubility for most metals between 8 and 9.5. It should be noted that



LEGEND

- - - - ELECTRICAL LEAD
[shaded] NEW EQUIPMEND
CC CONDUCTIVITY CONTROLLER
LAH LEVEL ALARM HIGH
LLS LEVEL LOW SWITCH
pHC pH CONTROLLER
OKP OXIDATION REDUCTION POTENTIAL

INDIANAPOLIS JOINT PRETREATMENT PLANT PROCESS FLOW DIAGRAM

FIGURE 4 - 1

unprecipitated trivalent chrome should not be mixed directly with the pretreated cyanide waste, because the chlorine in the cyanide treatment effluent can oxidize the trivalent chrome back to hexavalent chrome. Thus, neutralization of the chrome and general metals waste takes place in a separate tank from the neutralization and precipitation of the treated cyanide waste.

The clarification and thickening processes make use of relatively standard commercially availabe wastewater treatment units. Table 4-2 presents a list of the major equipment that will be required for the joint pretreatment facility.

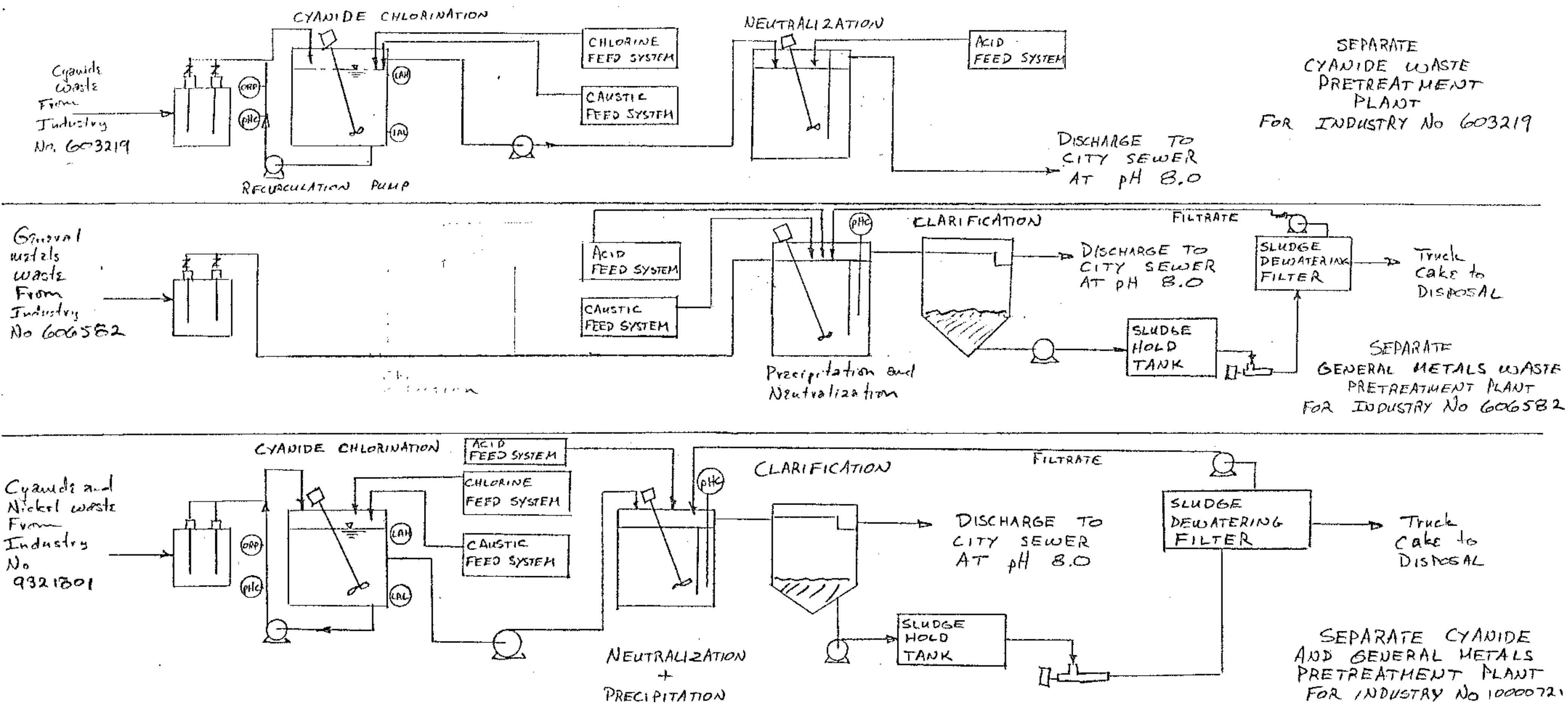
Separate Pretreatment Conceptual Design

Figure 4-2 presents a diagram of the facilities assumed to be implemented to provide comparable treatment to that of the joint pretreatment facility by means of separate pretreatment facilities at each of the five companies involved in the joint pretreatment project. Two of the industries are provided with small cyanide waste oxidation units. One of the industries is provided with a small general metals precipitation and sedimentation unit. The two largest industries are each provided with a hexavalent chrome reduction unit, a cyanide oxidation unit, as well as a general metals precipitation unit. Each of the industries which operates a precipitation process is required to include sludge dewatering equipment in their pretreatment plant. Table 4-3 lists the major pieces of equipment required for each of the separate pretreatment plants.

COST ANALYSIS

Joint Pretreatment Project Cost Estimate

Table 4-4 presents a summary of the costs included in the estimate for the joint pretreatment facility cost estimate. These are preliminary costs developed in order to facilitate comparison of alternative approaches to pretreatment problems. Therefore, certain items which may ultimately be included in the cost of the joint pretreatment facility, but which would be also included for separate



SEPARATE PRETREATMENT PLANTS FOR CYANIDE, CHROME, AND OTHER METALS FOR INDUSTRIES NO 606234 AND NO 603202, WILL BE AS SHOWN IN FIGURE 4-1.

INDIANAPOLIS SEPARATE PRETREATMENT PLANTS

FIGURE 4-2

TABLE 4-2

JOINT PRETREATMENT EQUIPMENT LIST

Description	Design Value
Design Flow	126,000 gpd
Average Cyanide Flow	17,600 gpd
Average Chrome (Hex) Flow	15,000 pgd
Cyanide Sump Pumps	
Number	2
Capacity, each	30 gpm
Size, each	3/4 hp
Cyanide Treatment Tanks	
Number	3
Capacity, each	2,800 gal
Treated Cyanide Transfer Pump	
Number	1
Capacity	30 gpm
Size	1-1/2 hp
Cyanide Recirculation Pump	
Number	1
Capacity	20 gpm
Size	1/2 hp
Chlorinator	
Number	1
Capacity	50 lb/day
Chrome Sump Pump	
Number	2
Capacity, each	30 gpm
Size, each	1 hp
Chrome Reduction Tank	
Number	1
Capacity	1,200 gallon
Diameter	5 ft
Height	8 ft
Chrome Reduction Tank Mixer	
Number	1
Size	1/2 hp
Type	Top Entry

TABLE 4-2 (Continued)

Description	Design Value
Sulfur Dioxide Feeder	
Number	1
Size	1lb/hr
Chrome Precipitation Tank	
Number	1
Capacity	600 gallon
Diameter	4 ft
Height	6 ft
Chrome Precipitation Tank Mixer	
Number	1
Size	1/4 hp
Neutralization Tank	
Number	1
Capacity	800 gallon
Diameter	5 ft
Height	5 ft
Flocculant Feed System	
Flocculant	Polymer
Dose Strength	1ppm
Clarifier	
Number	1
Size	10' x 30' - 7' S.W.D.
Average Surface overflow	400 gpd/sq ft
Sludge Pumps	
Number	2
Capacity	20 gpm
Size	1 hp
Sludge Dewatering	
Filter Press	0.5 ton/day wet cake production rate

TABLE 4-3

INDIANAPOLIS PRETREATMENT

SEPARATE PRETREATMENT EQUIPMENT LIST

Description	Design Value
Flows	
Cyanide Flows:	
Ind. No. 9321801	1,900 gpd
Ind. No. 1606234	3,000 gpd
Ind. No. 603219	4,700 gpd
Ind. No. 603202	8,000 gpd
Chrome Flows	
Ind. No. 606234	26,500 gpd
Ind. No. 603202	89,252 gpd
General Metals Flows	
Ind. No. 9321801	1,900 gpd
Ind. No. 606234	26,500 gpd
Ind. No. 606582	3,950 gpd
Ind. No. 603202	89,252 gpd
Cyanide Sump Pumps	
Number	8
Capacity	20 gpm
Size, each	1/2 hp
Cyanide Treatment Tanks	
Number, size 1	3
Capacity, each	1,400 gal
Number, size 2	2
Capacity, each	2,800 gal
Cyanide Tank Mixers	
Number	5
Size	1/2 hp
Treated Cyanide Transfer Pumps	
Number, size 1	3
Capacity	10 gpm
Size	1/2 hp
Number, size 2	1
Capacity	20 gpm
Size	1 hp

TABLE 4-3 (Continued)

Description	Design Value
Cyanide Recirculation Pump	
Number, size 1	3
Capacity	10
Size	1/4 hp
Number, size 2	1
Capacity	20 gpm
Size	1/2 hp
Chlorinator	
Number, size 1	3
Size	10 lb/day
Number, size 2	1
Size	50 lb/day
Chrome Sump Pumps	
Number	4
Capacity	20 gpm
Size	
Chrome Reduction Tanks	
Number, size 1	1
Capacity	600 gal
Number, size 2	1
Capacity	1,200 gal
Chrome Tank Mixers	
Number	2
Size	1/2 hp
Sulfur Dioxide Feeders	
Number	2
Size	1 lb/hr
Chrome Precipitation Tank	
Number	2
Capacity	600 gal
Chrome Precipitation Tank Mixer	
Number	2
Size	1/4 hp
Neutralization Tank	
Number, size 1	4
Capacity	600 gal
Number, size 2	1
Capacity	800 gal

TABLE 4-3 (Continued)

Description	Design Value
Neutralization Tank Mixers	
Number	5
Size	1/4 hp
Flocculant Feed System	
Number	4
Clarifiers	
Number, size 1	3
Size 1	8 ft diam.
Number, size 2	1
Size 2	10 ft diam.
Sludge Pumps	
Number	8
Capacity	20 gpm
Size	1 hp
Sludge Hold Tanks	
Number	4
Capacity	1,500 gal
Sludge Dewatering Filter	
Number, size 1	4
Capacity	1/4 ton/day
Number, size 2	
Capacity	1/2 ton/day

TABLE 4-4

ESTIMATED COSTS FOR JOINT PRETREATMENT

		Amount
Wastewater Pipelines (all 3" diameter coated steel)		
Ind. No. 9321801		
Cyanide line, 3,000 L.F.	$ 60,000	
Ind. No. 606234		
Cyanide line, 6,000 L.F.	120,000	
Chrome line, 6,000 L.F.	120,000	
General metals line, 6,000 L.F.	120,000	
Ind. No. 603219		
Cyanide line 3,000 L.F.	60,000	
Ind. No. 606582		
General metals line, 7,000 L.F.	140,000	
Ind. No. 603202		
Cyanide line, 200 L.F.	4,000	
Chrome line, 200 L.F.	4,000	
General metals line, 200 L.F.	4,000	
Subtotal		$ 632,000
Cyanide Treatment		
Tanks	$ 20,000	
Chlorinator and Scale	5,000	
Chlorinator Housing	5,000	
pH & ORP Control System	3,000	
Caustic Metering Pumps	4,000	
Cyanide Recirculating Pumps	4,000	
Piping and Valves	6,000	
Electrical	3,000	
Subtotal		$ 50,000
Chrome Treatment		
Tanks	$ 20,000	
Chrome Reduction Tank	7,000	
Chrome Precipitation Tank	5,000	
ORP Control System	2,000	
Piping and Valves	5,000	
Mixers	4,000	
Electrical	2,500	
Subtotal		$ 15,500
Clarification System		
Clarifier	$100,000	
Flocculant Feed System	25,000	
Inlet Modification	10,000	
Electrical	5,000	
Subtotal		$ 150,000
Sludge Handling System		
Filter Press	$ 30,000	
Sludge Pumps	15,000	
Above Ground Piping and Valves	2,000	
Underground Piping	35,000	
Electrical	3,000	
Subtotal		$ 85,000
Site Development		50,000
Subtotal		$1,078,000
Contingencies, 30%		323,400
Total Project Cost		$1,401,400

pretreatment facilities are not included in the table. The costs are developed on the basis of cost curves and cost estimates prepared for other detailed project designs. Consequently, these costs should be refined prior to their use for final design and construction. Table 4-5 lists the cost estimates for the five separate pretreatment facilities which would be required in place of the joint pretreatment facility. The costs on this table are prepared in a manner similar to those on Table 4-4. Neither the joint pretreatment costs nor the separate pretreatment costs include the costs for the sumps and pumps to be installed for each type of process waste at each plant, because these sumps are the same whether treatment is joint or separate. The cost estimates do not consider the value of the exisitng pretreatment facilities which are known to exist at three of the five industries. These facilities consist only of neuralization and, in some cases, filtration units. While the neutralization tankage would probably be utilized as part of new separate facilities, the filtration equipment would not. Thus, there is a potential for a minor reduction in separate pretreatment costs by salvage and utilization of existing tankage at three of the industries.

TABLE 4-5

ESTIMATED COSTS FOR SEPARATE PRETREATMENT

		Amount
Cyanide Treatment		
Tanks	$ 24,000	
Chlorinator and Scale	11,000	
Chlorinator Housing	11,000	
pH & ORP Control System	12,000	
Caustic Metering Pumps	16,000	
Cyanide Recirculating Pumps	10,000	
Piping and Valves	20,000	
Electrical	12,000	
Subtotal		$ 116,000
Chrome Treatment		
Chrome Reduction Tank	11,000	
Chrome Precipitation Tank	10,000	
ORP Control System	4,000	
Piping and Valves	10,000	
Mixers	8,000	
Electrical	5,000	
Subtotal		$ 48,00
Clarification System		
Clarifiers	$340,000	
Flocculant Feed System	100,00	
Electrical	5,000	
Subtotal		$ 460,000
Sludge Handling System		
Dewatering Filters	$ 90,000	
Sludge Pumps	60,000	
Above Ground Piping and Valves	8,000	
Underground Piping	120,000	
Electrical	120,000	
Subtotal		$ 290,000
Site Development		125,000
Subtotal		$1,039,000
Contingencies, 30%		312,000
Total Project Cost		$1,351,000

APPENDIX A

APPENDIX A

REFERENCES

1. Preliminary Draft Report for the CSO Study, by Howard, Needles, Tammen & Bergendoff, 8/23/82.

2. Combined Sewer Overflow Water Quality Impact Analysis, City of Indianapolis, Indiana, HNTB, undated.

3. Industrial Pretreatment Program, Task 3 Report, "Waste Characterization," prepared for the City of Indianapolis by JMM, November 1982.

4. Industrial Pretreatment Program, Task 4 Report, "Pilot Plant Results and Technical Ordinance Support Information," prepared for the City of Indianapolis by JMM, November 1982.

5. Graham, A. Kenneth, Electroplating Engineering Handbook, Third Edition, Van Nostrand Reinhold, New York, 1971.

APPENDIX B

APPENDIX B

CSO MONITORING DATA

This appendix contains data generated as part of the 1981 CSO monitoring study conducted by HNTB, which included analysis of CSO samples for inorganic priority pollutants and oil and grease. This appendix contains the following items suppllied to JMM by the City of Indianapolis:

1. Table 5.5 from the Preliminary Draft Report (Ref. 1) for the CSO study, dated 8/23/82. This table summarizes the industrial pollutant concentration data collected for CSO discharges.

2. Figures 5.1, 5.2, and 5.3 from Ref. 1, which illustrates the pollutant versus time data taken from a single CSO.

3. Table 5.8 from Ref. 1, which summarizes the wet weather stream sampling results, and in particular lists the river flowrates that coincide with monitored CSO events.

4. The Stream Sampling Location Map from Ref. 1.

TABLE 5.5

SUMMARY OF COMBINED SEWER OVERFLOW SAMPLING RESULTS

CSO No.	013		023			
Sampling Date	7/18	8/30	7/18	8/10	8/27	8/30
Rainfall, inches	.4	1.06	.4	.22	.40	1.06
Total Overflow, gal.	3,500	103,000	22,500	400	4,000	88,600
pH						
BOD_5, mg/l	-	32	85	100	1,439	11
lbs.	-	27	16	.3	48	8.3
TSS, mg/l	-	471	432	150	2,428	279
lbs.	-	405	81	.5	81	206
Settleable Solids, mg/l		-	4	-	-	-
lbs.			0.8			
Total P, mg/l	-	1.3		2.10	5.70	.76
lbs.	-	1.1		.007	.19	.56
NO_3-N, mg/l	-	.26	8.0	.90	.18	.22
lbs.	-	.22	1.5	.003	.006	.16
NH_4-N, mg/l	-	.56	.27	2.10	2.40	.50
lbs.	-	.48	.05	.007	.08	.37
TKN, mg/l	-	4.8	50.1	12.0	42.0	2.9
lbs.	-	4.1	9.4	.04	1.4	2.2
Cu, mg/l	-	.02	.11	-	.60	.07
lbs.	-	.02	.0002	-	.02	.05
Pb, mg/l	-	.86	.79	-	1.80	.48
lbs.	-	.74	.002	-	.06	.35
Zn, mg/l	-	.31	.64	-	2.10	.30
lbs.	-	.27	.001	-	.07	.22
Cr, mg/l	-	<.05	<.10	-	.02	<.001
lbs.	-	<.04	<.0002	-	.0008	<.001
Cd, mg/l	-	<.004	<.01	-	.02	<.001
lbs.	-	<.003	<.0002	-	.0008	<.001
Ni, mg/l	-	.02	<.05	-	.15	.01
lbs.	-	.02	<.05	-	.005	.008
Oil & Grease, mg/l	-	11	-		30.0	1.2
lbs.	-	9.2	-	.5	1	.88
Fecal Coliform, 10^6/100 ml	-	.05	-	-	.13	.01
$x10^9$	-	200	2	.0003	20	>40

Table 5.5
(Continued)

CSO No.	029		037			043
Sampling Date	8/05	8/10	7/18	8/10	8/30	7/18
Rainfall, inches		.20	.4	.2	1.06	
Total Overflow, gal.	2,600	12,200	35,500	700	20,500	290,000
pH	-		-	-		-
BOD_5, mg/l	-	110	-	-	26	-
lbs.	-	11	-	-	4.5	-
TSS, mg/l	-	87	-	-	380	-
lbs.	-	8.9	-	-	65	-
Settleable Solids, mg/l			-	-		
Total P, mg/l	-	1.4	-	-	1.6	-
lbs.	-	.14	-	-	.27	-
NO_3-N, mg/l	-	<.1	-	-	1.9	-
lbs.	-	<.10	-	-	.33	-
NH_4-N, mg/l	-	2.6	-	-	.04	-
lbs.	-	.26	-	-	.007	-
TKN, mg/l	-	21	-	-	3.8	-
lbs.	-	2.1	-	-	.65	-
Cu, mg/l	-	.06	-	-	1.4	-
lbs.	-	.006	-	-	.23	-
Pb, mg/l	-	.07	-	-	.82	-
lbs.	-	.007	-	-	.14	-
Zn, mg/l	-	.22	-	-	.57	-
lbs.	-	.02	-	-	.10	-
Cr, mg/l	-	.01	-	-		-
lbs.	-	.001	-	-	<.003	-
Cd, mg/l	-	<.01	-	-		-
lbs.	-	<.001	-	-	<.001	-
Ni, mg/l	-	.01	-	-		-
lbs.	-	.0011	-	-	.014	-
Oil & Grease, mg/l	-	<12	-	-	-	-
lbs.	-	<1.2	-	-	-	-
Fecal Coliform, 10^6/100 ml	-	-	-	-	-	-
x 10^9	-	>.005	-	-	-	-

Table 5.5
(Continued)

CSO No. / Sampling Date	043 8/05	043 8/30	050A 7/18	050A 8/05	050A 8/30	052 7/18
Rainfall, inches					.45	
Total Overflow, gal.	167,000	561,000	345,000	60,500	447,000	76,400
pH						
BOD_5, mg/l	20.4	13.5	-	129	55.9	-
lbs.	28.4	63.2	-	65	15	-
TSS, mg/l	267	105	-	430	48.5	-
lbs.	371.9	490.9	-	217	13	-
Settleable Solids, mg/l	[illegible]	-		[illegible]		
Total P, mg/l	8.64	.62	-	3.37	.82	-
lbs.	12.03	2.88	-	1.9	.22	-
NO_3-N, mg/l	.45	.42	-	7.93	0	-
lbs.	.63	1.95	-	4.0	-	-
NH_4-N, mg/l	.31	1.01	-	.36	.22	-
lbs.	.43	4.74	-	.18	.06	-
TKN, mg/l	42.5	5.11	-	21.8	.45	
lbs.	59.22	23.93	-	11	.12	-
Cu, mg/l	.30	.04	-	.28	-	-
lbs.	.412	.167	-	.14	-	-
Pb, mg/l	.17	.23	-	.30	.11	-
lbs.	.236	1.079	-	.15	.03	-
Zn, mg/l	.57	.24	-	.50	.11	-
lbs.	.797	1.102	-	.25	.03	-
Cr, mg/l	.08	.04	-	.10	.007	-
lbs.	.108	.165	-	.05	.002	-
Cd, mg/l	.80	.01	-	.10	.002	-
lbs.	1.110	.065	-	.05	.006	-
Ni, mg/l	.08	.06	-	.10	.011	-
lbs.	.108	.298	-	.05	.003	-
Oil & Grease, mg/l	41.4	9.6	-	13.9	-	-
lbs.	57.7	45.1	-	7	-	-
Fecal Coliform, 10^6/100 ml	.09	.12	-	.01	-	-
$x10^9$	539	2610	-	70	-	-

Table 5.5
(Continued)

CSO No.	052	060		062		
Sampling Date	8/30	7/18	8/30	7/18	~~8/05~~	~~8/10~~
Rainfall, inches	.30					
Total Overflow, gal.	522,000	407,000	15,700			
pH	–	–				
BOD_5, mg/l	–	–	199			
lbs.	–	–	26			
TSS, mg/l	–	–	787			
lbs.	–	–	103			
Settleable Solids, mg/l						
Total P, mg/l	–	–	5.35			
lbs.	–	–	.7			
NO_3-N, mg/l	–	–	.06			
lbs.	–	–	.008			
NH_4-N, mg/l	–	–	–			
lbs.	–	–	–			
TKN, mg/l	–	–	22.1			
lbs.	–	–	2.9			
Cu, mg/l	–	–	.38			
lbs.	–	–	.05			
Pb, mg/l	–	–	.92			
lbs.	–	–	.12			
Zn, mg/l	–	–	1.45			
lbs.	–	–	.19			
Cr, mg/l	–	–	.07			
lbs.	–	–	.009			
Cd, mg/l	–	–	.015			
lbs.	–	–	.002			
Ni, mg/l	–	–	.08			
lbs.	–	–	.01			
Oil & Grease, mg/l	–	–	107			
lbs.	–	–	14			
Fecal Coliform, 10^6/100 ml	–	–	.19			
$x10^9$	–	–	110			

Table 5.5
(Continued)

CSO No.	077				090	
Sampling Date	7/18	8/10	8/27	8/30	7/18	8/10
Rainfall, inches	.6	.2	.35	.56		
Total Overflow, gal.	13,000	3,500	20,000	15,600	600,000	611,000
pH						
BOD_5, mg/l	15.7	610	540	13.8	–	12.4
lbs.	1.7	17.8	90	1.8	–	63
TSS, mg/l	36.0	1723	1757	335	–	273
lbs.	3.9	50.3	293	43.6	–	1390
Settleable Solids, mg/l	7	–				
Total P, mg/l	2.8	8.9	3.12	.31	–	1.9
lbs.	–	.26	.52	.04	–	9.5
NO_3-N, mg/l	2.9	1.4	–	.15	–	1.0
lbs.	.31	.04	–	.02	–	5.3
NH_4-N, mg/l	–	5.5	1.5	.02	–	.49
lbs.	–	.16	.25	.002	–	2.5
TKN, mg/l	4.8	57.9	19.2	3.6	–	7.1
lbs.	.52	1.69	3.2	.47	–	36
Cu, mg/l	–	.31	.12	.04	–	.14
lbs.	–	.009	.02	.005	–	.69
Pb, mg/l	–	.48	.84	.54	–	.10
lbs.	–	.014	.14	.070	–	.51
Zn, mg/l	–	.96	.54	.31	–	.18
lbs.	–	.028	.09	.040	–	.90
Cr, mg/l	–	.89	.02	.008	–	.03
lbs.	–	.026	.004	.001	–	.15
Cd, mg/l	–	.45	.006	.008	–	.01
lbs.	–	.013	.001	.001	–	.05
Ni, mg/l	–	18.49	.042	.04	–	.02
lbs.	–	.054	.007	.005	–	.11
Oil & Grease, mg/l	–	6.7	2.46	13.9	–	13
lbs.	–	.197	.41	1.81	–	67
Fecal Coliform, 10^6/100 ml	–	–	.12	538	–	–
$x10^9$	.7	.004	90	70	–	.7

Table 5.5
(Continued)

CSO No.	107		115		118	
Sampling Date	7/18	8/30	8/27	8/30	7/18	8/27
Rainfall, inches	.6	.87		.45	.4	.5
Total Overflow, gal.	569,000	1,540,000	164,000	2,650,000	469,000	318,000
pH						
BOD_5, mg/l	-	16.7	105	190	-	33
lbs.	-	215	144	4190	-	88.8
TSS, mg/l	-	331	797	986	-	267
lbs.	-	4247	1090	21,800	-	707
Settleable Solids, mg/l					-	-
Total P, mg/l	-	1.21	2.6	4.5	-	.66
lbs.	-	15.50	3.5	99	-	1.76
NO_3-N, mg/l	-	1.18	.56	1.0	-	.52
lbs.	-	15.20	.77	22	-	1.39
NH_4-N, mg/l	-	1.04	.95	.72	-	1.81
lbs.	-	13.42	1.3	16	-	4.79
TKN, mg/l	-	3.22	9.5	9.0	-	9.28
lbs.	-	41.36	13	200	-	24.62
Cu, mg/l	-	.08	.53	.68	-	.07
lbs.	-	1.03	.72	.15	-	.189
Pb, mg/l	-	.44	.80	.45	-	.47
lbs.	-	5.63	1.1	10	-	1.247
Zn, mg/l	-	.32	.80	1.4	-	.30
lbs.	-	4.11	1.1	30	-	.805
Cr, mg/l	-	.01	.24	.32	-	.04
lbs.	-	.147	.33	7	-	.119
Cd, mg/l	-	.01	.01	.02	-	.01
lbs.	-	.147	<.01	.37	-	.020
Ni, mg/l	-	.03	.12	.12	-	.08
lbs.	-	.36	.16	2.7	-	.213
Oil & Grease, mg/l	-	7.9	8.0	31.7	-	.90
lbs.	-	102	11	700	-	2.4
Fecal Coliform, 10^6/100 ml	-	.11	.10	.09	-	.07
$x10^9$	-	6150	600	9400	-	800

Table 5.5
(Continued)

CSO No.	118	119			120	
Sampling Date	8/30	7/18	8/10	8/27	7/18	8/10
Rainfall, inches	1.06	.4	.22	.5	.4	.22
Total Overflow, gal.	805,000	87,600	56,600	116,000	102,000	97,100
pH						
BOD_5, mg/l	29	-	160	-	39	147
lbs.	193	-	75.3	-	33	119
TSS, mg/l	693	-	37	-	1050	2272
lbs.	4650	-	17.4	-	893	1840
Settleable Solids, mg/l						
Total P, mg/l	1.8	-	1.9	-	-	7.4
lbs.	12	-	.89	-	-	6.0
NO_3-N, mg/l	.43	-	1.0	-	14	1.16
lbs.	2.9	-	.48	-	12	.94
NH_4-N, mg/l	.67	-	19	-	.47	10.4
lbs.	4.5	-	9.1	-	.40	8.4
TKN, mg/l	8.0	-	25	-	141	32
lbs.	54	-	11.84	-	120	26
Cu, mg/l	.30	-	-	-	-	.63
lbs.	2	-	-	-	-	.51
Pb, mg/l	1.8	-	-	-	-	.46
lbs.	12	-	-	-	-	.37
Zn, mg/l	.82	-	-	-	-	4.1
lbs.	5.5	-	-	-	-	3.3
Cr, mg/l	.07	-	-	-	-	11.0
lbs.	.46	-	-	-	-	8.9
Cd, mg/l	.01	-	-	-	-	.06
lbs.	.06	-	-	-	-	.05
Ni, mg/l	.08	-	-	-	-	2.2
lbs.	.55	-	-	-	-	1.8
Oil & Grease, mg/l	15	-	20	-	-	395
lbs.	99	-	9.5	-	-	320
Fecal Coliform, 10^6/100 ml	-	-	-	-	.002	-
$x10^9$	20	-	.035	-	6	.07

Table 5.5
(Continued)

CSO No.	120	133		
Sampling Date	8/30	7/18	8/10	8/30
Rainfall, inches	1.06	.6	.2	.87
Total Overflow, gal.	997,000	8,000	300	4,400
pH				
BOD_5, mg/l	168	34	92	12
lbs.	1398	2.3	.23	.45
TSS, mg/l	1098	896	999	125
lbs.	9130	58	2.5	4.6
Settleable Solids, mg/l				
Total P, mg/l	4.63	.2	4.0	.27
lbs.	38.52	-	.01	.01
NO_3-N, mg/l	.08	12	2.0	-
lbs.	.70	.8	.005	-
NH_4-N, mg/l	7.1	.15	1.2	.16
lbs.	59.19	.01	.003	.006
TKN, mg/l	20.4	22	16	.90
lbs.	169.8	1.5	.04	.033
Cu, mg/l	.28	-	-	-
lbs.	2.30	-	-	-
Pb, mg/l	.19	-	-	.16
lbs.	1.57	-	-	.006
Zn, mg/l	.83	-	-	.16
lbs.	6.89	-	-	.006
Cr, mg/l	.62	-	-	-
lbs.	5.18	-	-	-
Cd, mg/l	.02	-	-	.016
lbs.	.125	-	-	.0006
Ni, mg/l	.48	-	-	-
lbs.	3.98	-	-	-
Oil & Grease, mg/l	112	-	24	55
lbs.	934	-	.06	2
Fecal Coliform, 10^6/100 ml	.15	.003	-	.18
$x10^9$	5801	1	.0005	30

Table 5.5
(Continued)

CSO No.	141			142		
Sampling Date	7/18	8/05	8/30	7/18	8/05	8/30
Rainfall, inches						
Total Overflow, gal.	183,000	1,500	2,560,000	1,420,000	184,000	8,860,000
pH						
BOD_5, mg/l	-	96	113	-	560	142
lbs.	-	1.2	2420	-	859	10,477
TSS, mg/l	-	1567	-	-	2196	293
lbs.	-	19.6	-	-	3370	21,660
Settleable Solids, mg/l		19 .2			6 9	
Total P, mg/l	-	16	-	-	26	6.5
lbs.	-	.20	-	-	40	479.1
NO_3-N, mg/l	-	1.1	.26	-	.14	.02
lbs.	-	.014	5.5	-	.21	1.60
NH_4-N, mg/l	-	0	.56	-	3.1	3.8
lbs.	-	0	12	-	4.7	278.9
TKN, mg/l	-	60	8.5	-	149	17.8
lbs.	-	.75	181	-	228	1315
Cu, mg/l	-	2.2	-	-	.52	.11
lbs.	-	.027	-	-	.80	8.20
Pb, mg/l	-	1.0	-	-	.61	.09
lbs.	-	.013	.01	-	.93	6.71
Zn, mg/l	-	2.2	-	-	1.2	.23
lbs.	-	.027	.01	-	1.9	17.22
Cr, mg/l	-	.32	-	-	.22	.01
lbs.	-	.004	.00001	-	.34	.601
Cd, mg/l	-	.40	-	-	2.3	.01
lbs.	-	.005	.00001	-	3.6	.521
Ni, mg/l	-	.32	-	-	.16	.01
lbs.	-	.004	.00001	-	.24	.899
Oil & Grease, mg/l	-	58	16	-	3.9	27
lbs.	-	.73	340	-	6	1999
Fecal Coliform, 10^6/100 ml	-	.07	.09	-	.10	.03
$x10^9$	-	4.1	8900	-	700	10,900

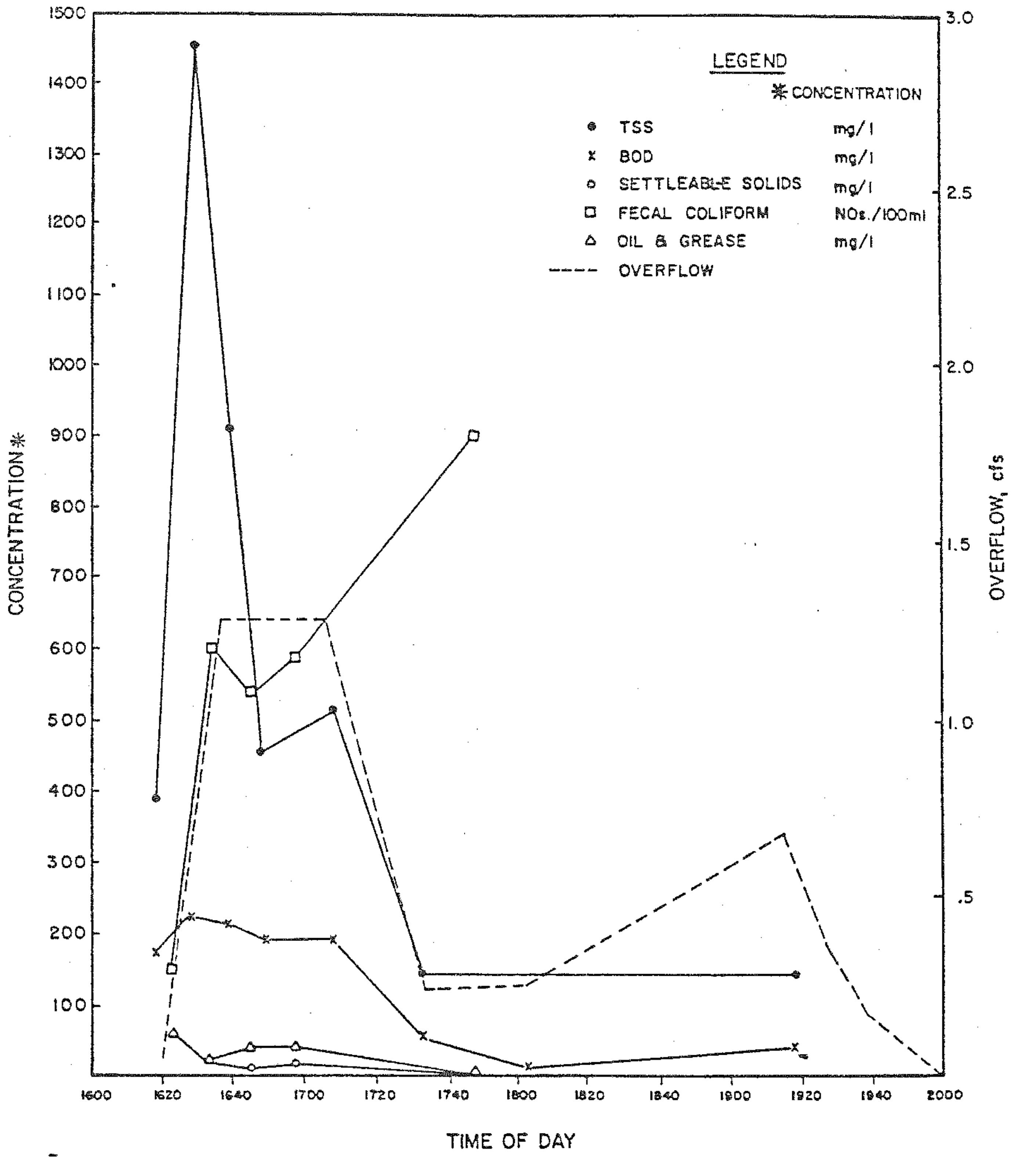


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FIGURE 5.1
POLLUTANT CONCENTRATION vs. TIME
FOR CSO 050A (AUG. 5, 1981 STORM)
INDIANAPOLIS CSO STUDY

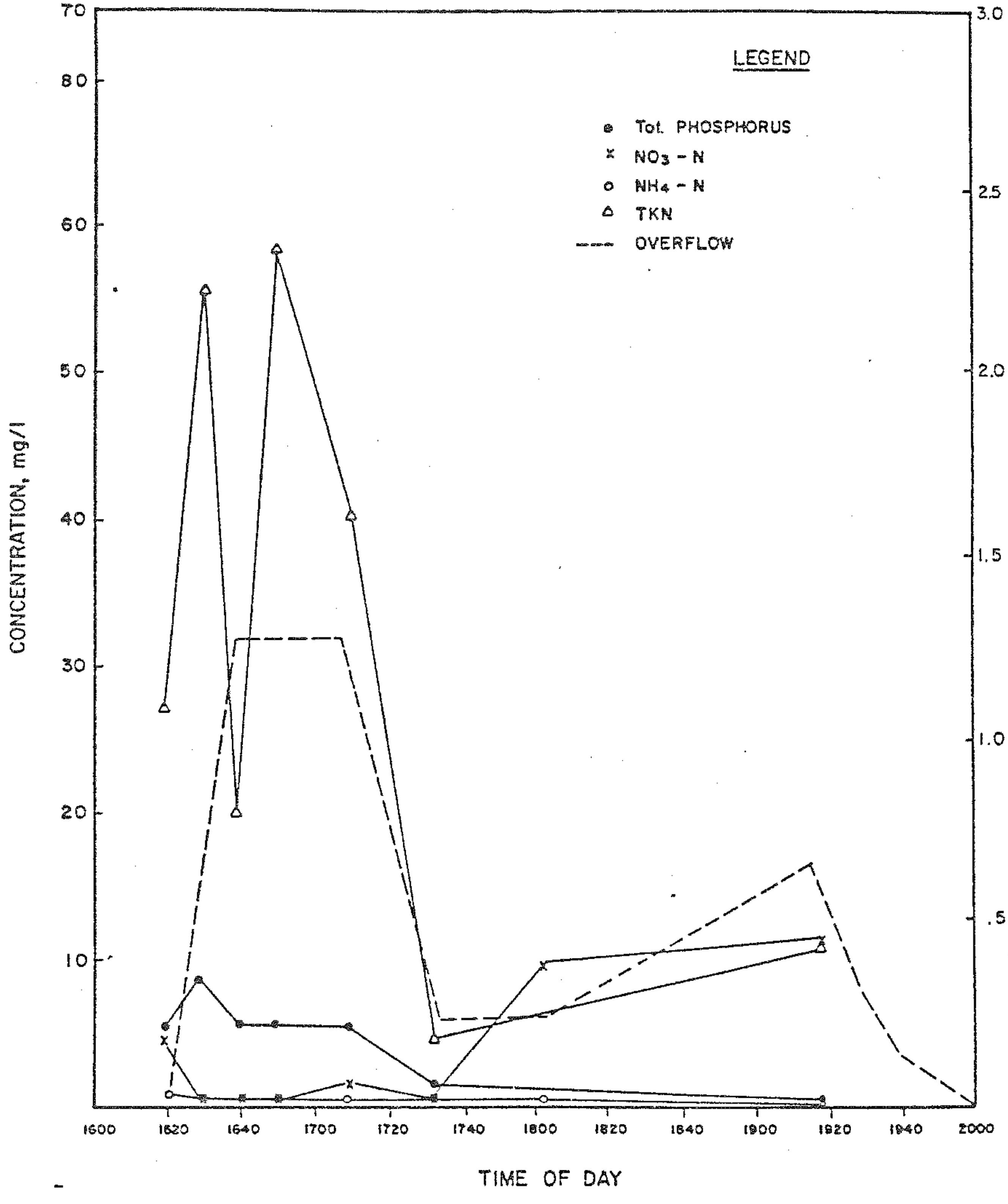

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FIGURE 5.2
POLLUTANT CONCENTRATION vs. TIME
FOR CSO 050A (AUG. 5, 1981 STORM)
INDIANAPOLIS CSO STUDY

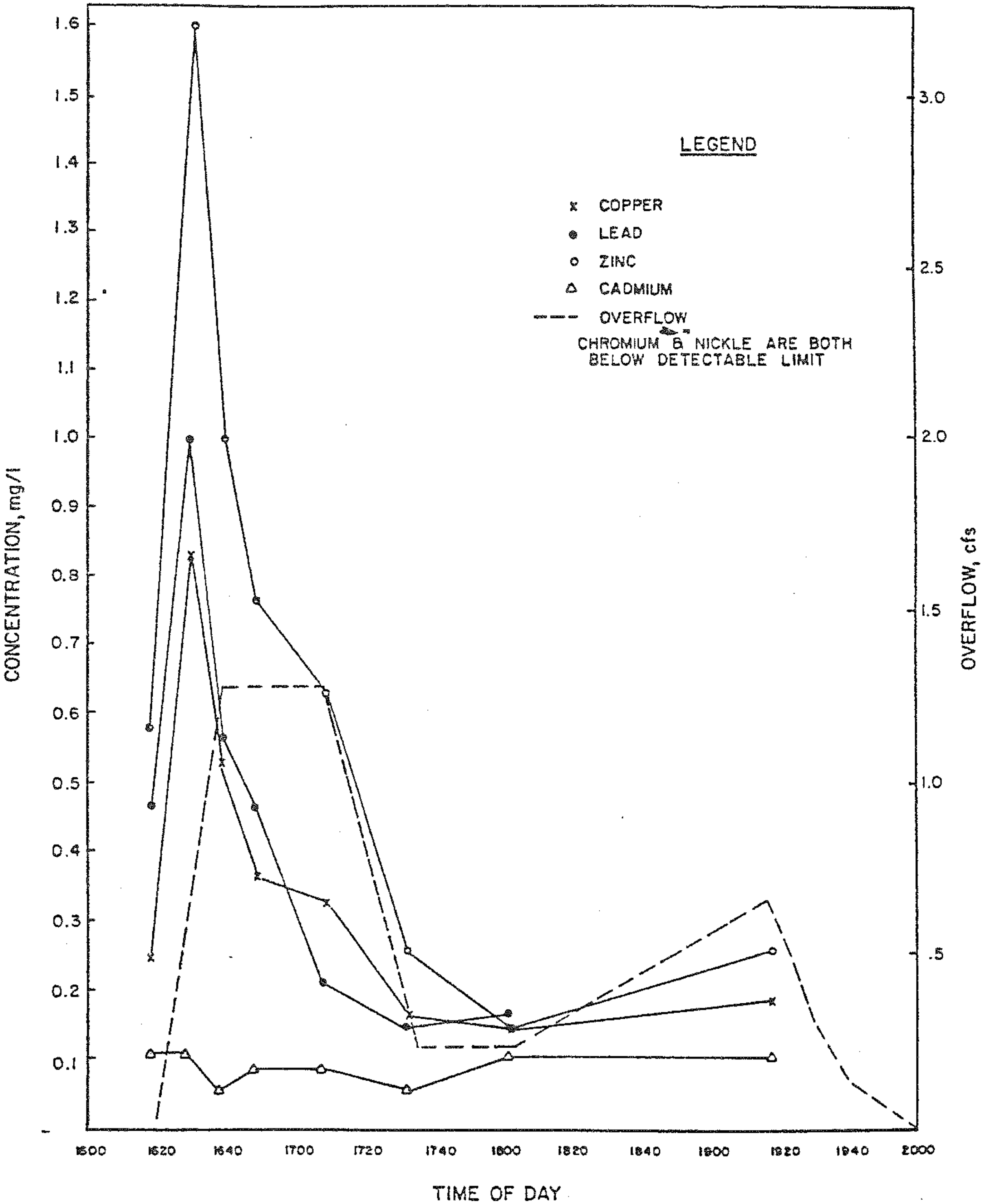

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FIGURE 5.3
POLLUTANT CONCENTRATION vs. TIME FOR CSO 050A (AUG. 5, 1981 STORM)
INDIANAPOLIS CSO STUDY

TABLE 5.8

SUMMARY OF WET-WEATHER STREAM SAMPLING RESULTS

WHITE RIVER - AUGUST 5, 1981

Sampling Site	WR 1	WR 2	WR 3	WR 4	WR 5	WR 6	WR 7	WR 8	WR 9	WR 10
Flow (cfs)	623-1798	625-1910	1421-1925	1689-1839	2753-2913	3841-3954	2210-2400	2442-2562		
Temperature (°C)	24-25	23.5-25	23-35	25	25-26.5	25-26.5	24.5-25	24.5-26.5	25-26	24.5-25
pH	7.3-7.4	7.5-7.6	7.4-7.5	7.6	8.1-8.2	7.9-8.1	7.8-8.0	7.7-7.8		
Conductivity	580-820	550-810	550-790	550-800	870-960	840-920	750-900	810-920		
D.O.	7.2-8.1	7.5-8.8	7.2-7.7	7.7-8.4	5.9-6.3	4.7-5.0	4.7-5.5	4.9-6.5	5.1-7.2	5.4-5.8
BOD_5	5-6	4-7	3-6	1-2	6-11	7-11	5-13	5-8		
TSS	4-73	26-54	36-61	56-73	16-48	11-44	42-56	25-52		
Total P*	3.23-3.43	2.8-3.36	3.64-3.92	3.19-4.20	3.36-3.76	3.33-3.96	3.33-3.92	3.53-4.70		
NO_3-N*	2.4-4.0	3.7-4.35	2.06-4.8	3.0-4.4	4.5-5.65	4.71-6.28	4.17-5.23	4.59-5.34		
NH_4-N	.01	.01	.01	.01	.01	.01	.01	.01		
TKN*	11.2-27.0	4.7-15.5	8.0-23.0	2.5-38	4.7-22.6	.1-36	1.3-15.5	2.5-34.0		
Cu	<.1	<.1	<.1	<.1	<.05-.17	<.05-.17	<.05-.15	.13-.19		
Pb	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2		
Zn	.03	.02-.07	<.01-.03	.02-.04	<.01-.22	<.01-.21	<.01-.07	<.01-.05		
Cr	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1		
Cd	<.05	<.05	<.05	<.05	<.05-.31	<.05	<.05	<.05		
Ni	<.1	<.1	<.1	<.01	<.1	<.1	<.1	<.1		
Oil & Grease	<1	4	1	4	6	7	7	6		
Fecal Coliform	850-15,000	50-15,000	<1-19,500	2,000-22,900	<1-58,500	<1-27,000	550-16,500	<1-24,000		

All units are in mg/l except as noted; and pH has no unit, conductivity is in umho/cm, and fecal coliform is in organisms/100 ml.
*Questionable results.

TABLE 5.9

SUMMARY OF WET-WEATHER STREAM SAMPLING RESULTS

WHITE RIVER - AUGUST 10, 1981

Sampling Site	WR 1	WR 2	WR 3	WR 4	WR 5	WR 6	WR 7	WR 8	WR 9	WR 10
Flow (cfs)	593-611	625-695	550-750	571-610	1495-1596	2492	1225	1079-1096		
Temperature (°C)	23.5-24	24-24.5	24-24.5	24	23-26.5	23-24.5	23.5-24	23.5-26		
pH	8.3-8.4	8.3-8.5	8.3-8.4	8.3-8.5	7.7-7.9	7.6-7.8	7.6-7.9	7.7		
Conductivity	760-800	720-810	700-820	750-770	870-960	790-960	910-970	880-1030		
D.O.	8.1-9.0	9.2-10.7	7.4-8.2	7.5-9.5	5.3-9.7	3.4-4.3	3.3-3.7	4.3-5.2		
BOD_5	3-7	1-4	<1-7	1-3	2-7	<1-3	3-7	3-7		
TSS	42-62	25-38	28-38	34-65	17-24	13-18	10-19	6-17		
Total P	<.06-.69	.12-.78	.06-.69	<.06-.33	.36-1.8	.53-.96	.1-.78	.54-.81		
NO_3-N	3.0-3.6	3.0-3.7	2.6-3.2	2.5-3.3	2.0-3.0	2.5-3.0	2.2-2.8	2.0-7.5		
NH_4-N	<.1-.38	<.1-2.2	<.1-.38	<.1-.3	2.9-4.3	2.2-3.4	1.5-2.2	1.2-1.95		
TKN	1.0-1.9	.87-2.0	1.1-1.9	1.0-2.5	1.2-5.0	3.5-4.8	2.1-3.0	1.9-3.2		
Cu	<.01-.01	<.01-.1	<.01	<.01	<.01-.01	<.01-.01	<.01	<.01		
Pb	<.005-.005	<.005-.01	<.005-.02	<.01-.015	<.005	<.005	<.01	<.01		
Zn	<.1	<.1	<.1	<.1	<.1-.1	<.1	<.1	<.1		
Cr	<.01	<.01	<.01	<.01	<.01	<.01	<.01-.01	<.01		
Cd	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01		
Ni	<.01	<.01	<.01	<.01	<.01	<.01-.03	<.01-.03	<.01-.01		
Oil & Grease	2	3	2	2	2	1	2	2		
Fecal Coliform	>16	>16	>16	>16	>16	>16	>16	>16		

All units are in mg/l except as noted; and pH has no unit, conductivity is in umho/cm, and fecal coliform is in organisms/100 ml.

TABLE 5.10

SUMMARY OF WET-WEATHER STREAM SAMPLING RESULTS

WHITE RIVER - AUGUST 15, 1981

Sampling Site	WR 1	WR 2	WR 3	WR 4	WR 5	WR 6	WR 7	WR 8	WR 9	WR 10
Flow (cfs)	432-436.5	445-560	290-550	483-656	1368-1508	2371-2478	1560	861		
Temperature (°C)	20.5-22.5	24-24.5	23.5-24	23.5-24	23.5-24.5	22-23	22-23.5	21.5-22	23-24	21-24
pH	8.2-8.3	8.0-8.6	8.0-8.2	8.1-8.4	7.6-7.7	7.6	7.6	7.5-7.6		
Conductivity	790-820	700-750	670-750	650-780	970-1140	980-1020	930-960	840-930		
D.O.	5.1-10.1	14.5-20	8.5-11.2	8.2-9.6	1.9-4.9	2.1-3.1	3.2-4.8	3.5-4.0	6.0-8.1	6.1-8.7
BOD_5	3-11	<1-13	2-11	1-5	8->25	<1->24	3-14	1-9		
TSS	26-49	19-45	18-32	13-46	1-15	1-70	1-20	<1-9		
Total P	.24-.75	.12-.39	.03-.07	.07-1.8	.88-1.8	.39-.69	.18-.51	.33-.66		
NO_3-N	.5-2.5	1.0-1.3	1.0-1.8	1.0-1.5	1.0-1.3	1.0-1.5	1.3-1.7	1.8-2.3		
NH_4-N	<.1-.15	<.1-.13	<.1-.11	<.1-.1	<.1-5.6	3.3-4.7	<.1	1.2-1.9		
TKN	.9-1.7	1.3-2.2	1.4-3.0	1.2-3.0	5.7-9.6	4.5-9.3	.63-1.1	2.1-6.0		
Cu	<.01-.01	.01	.01-.02	.01	.01-.02	<.01-.01	<.01-.02	.01		
Pb	<.05-.18	<.05-.05	<.005	<.05	<.05-.14	<.005-.04	<.05	<.005-1.0		
Zn	.01-.02	.02-.15	.02-.038	.025-.043	.045-.72	.032-.054	.02-.063	.015-.033		
Cr	<.01-.01	<.01-.01	<.01	<.01	<.01	<.01-.01	<.01	<.01		
Cd	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01		
Ni	<.01-.01	<.01	<.01-.04	<.01	<.01-.05	.02-.03	<.01-.03	<.01-.01		
Oil & Grease	2	2	2	1	3	1	1	1		
Fecal Coliform	>16	>16	>16	>16	>16	>16	-	>16		

All units are in mg/l except as noted; and pH has no unit, conductivity is in umho/cm, and fecal coliform is in organisms/100 ml.

TABLE 5.11

SUMMARY OF WET-WEATHER STREAM SAMPLING RESULTS

WHITE RIVER - AUGUST 30, 1981

Sampling Site	WR 1	WR 2	WR 3	WR 4	WR 5	WR 6	WR 7	WR 8	WR 9	WR 10
Flow (cfs)	1661	585-2595	1250-2040	742-2298	2406-3956	4008-6375	6795-10,700			
Temperature (°C)	22	23.4-25.1	22.7-24.4	22-24	23.7-26	23.3-24	24.3-25.3	23.5-24.2	24.0-24.5	24.0
pH	8.4	7.9-8.3	7.7-7.9	7.7-7.9	7.5-7.6	7.6-7.7	7.4-7.5	8.0-8.1		
Conductivity	780	840-920	730-870	680-920	820-1090	800-870	610-730	560-600		
D.O.	8.0	10-14.1	6.7-9.2	7.1-8.2	4.0-5.2	1.9-4.7	3.9-9.4	5.9-6.3	6.0-6.4	5.2-5.5
BOD_5	6	<1-7	<2-6	<1-5	11-16	10->21	6-12	4-7		
TSS	327	52-69	44-196	24-67	27-776	47-240	67-190	110-183		
Total P	.54	.18-.36	.02-.57	.12-.39	<.03-.99	.04-.81	.09-1.8	.36-2.2		
NO_3-N	.85	.30-.35	.25-.45	.3-.5	.5-1.8	.7-1.6	1.0-2.0	1.7-2.4		
NH_4-N	.081	.02-.15	.19-.51	.15-.51	.31-5.8	.52-4.2	.12-.53	.25-.37		
TKN	1.8	.96-.20	.9-2.1	1.1-1.9	3.6-8.7	1.5-5.7	1.2-2.6	.75-1.8		
Cu	.03	<.01	<.01-.06	<.01-.04	<.01-.02	<.01-.06	<.01-.03	<.01-.02		
Pb	.06	.04-.90	<.05-.16	.02-.10	<.05-.16	.04-.14	.04-.10	<.05-.42		
Zn	.065	.015-.043	.03-.054	.03-.06	.075-.11	.08-.11	.05-076	.05-063		
Cr	<.01	<.01	<.01	<.01-.02	<.01	<.01	<.01-.02	<.01		
Cd	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01		
Ni	0.04	<.01-.06	<.01-.06	<.01-.04	<.01-.05	<.01-.06	<.01-.05	<.01-.04		
Oil & Grease	5	2	3	97	4	2	<1	<1		
Fecal Coliform	10^3	10^2-10^4	10^3-10^5	10^3-10^5	10^4-10^5	10^4-10^5	10^3-10^5	10^3-10^4		

All units are in mg/l except as noted; and pH has no unit, conductivity is in umho/cm, and fecal coliform is in organisms/100 ml.

TABLE 5.12

SUMMARY OF WET-WEATHER STREAM SAMPLING RESULTS

WHITE RIVER - SEPTEMBER 29, 1981

Sampling Site	WR 1	WR 2	WR 3	WR 4	WR 5	WR 6	WR 7	WR 8	WR 9	WR 10
Flow (cfs)	336-340	282-393	207-252	276-283	1368-1495	2203-2310				
Temperature (°C)	15-16	27	10.5-17	16.9-1.80	18-18.5	17-18.5	19.5-20	19-20	19-20	18-20.5
pH	8.0	7.9-8.0	7.9-8.0	7.8-8.0	7.6-7.7	7.7-7.8	7.5-7.6	7.5-7.6		
Conductivity	920-930	780-840	770-820	640-800	960-1090	1090-1150	1100-1140	1070-110		
D.O.	9.5-10.5	11.4-13.3	8.6-9.9	8.1-10.0	4.6-7.4	4.4-7.2	4.9-6.5	4.8-7.0	5.4-7.1	6.4-8.7
BOD_5	4-8	5-8	5-7	6-36	7-15	8-14	6-12	6-9		
TSS										
Total P										
NO_3-N										
NH_4-N	.03-.16	.08-.13	.15-.23	.11-.66	5.5-7.9	4.6-6.8	5.3-5.7	4.1-5.5		
TKN										
Cu										
Pb										
Zn										
Cr										
Cd										
Ni										
Oil & Grease										
Fecal Coliform										

All units are in mg/l except as noted; and pH has no unit, conductivity is in umho/cm, and fecal coliform is in organisms/100 ml.

TABLE 5.13

SUMMARY OF WET-WEATHER STREAM SAMPLING RESULTS

TRIBUTARIES - AUGUST 5, 1981

Sampling Site	FC 1	FC 2	PGR 1	PGR 2	PLR 1	PLR 2	EC 1	EC 2
Flow (cfs)	-	145-1350	.14	4.48	10.5	14.3-20	-	132-133
Temperature (°C)	24	23.5-24	22.5-24	24-25	23-24	24.5-30	21.5-23	25-28
pH	7.2	7.1-7.2	7.0-7.2	6.9-7.0	6.6-6.9	7.2-7.6	7.0-7.3	7.0-7.1
Conductivity	-	-	-	-	-	-	-	-
D.O.	6.8-8.4	6.7-7.1	5.7-6.9	2.8-3.3	5.5-6.2	8.9-12.3	6.7-7.7	6.5-7.5
BOD_5	6-10	4-7	4	3-7	5-6	1-7	1-2	5-6
TSS	12-26	35-80	17-53	5-13	13-79	6-14	7-14	12-24
Total P*	2.63-2.83	3.08-3.92	3.43-3.84	3.92-5.59	3.03-3.44	3.36-5.32	3.36-3.92	2.82-3.57
NO_3-N*	1.05-1.18	.11-.17	.07-.28	.86-3.25	.72-1.19	1.8-2.55	1.6-2.2	2.75
NH_4-N	.01	.01	.01	.01	.01	.01	.01	.01
TKN*	5.7-19.0	.2-15.5	13.5-20.0	20.0-45.0	12.5-34.0	.1-29.0	1.3-25.0	5.7-29.4
Cu	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Pb	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
Zn	.02-.06	.02-.07	.02-.03	.02-.03	.03-.1	.01-.03	<.01-.03	.02-.04
Cr	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Cd	<.05	<.05	<.05	<.05	<.05	<.05-.11	<.05	<.05-.5
Ni	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Oil & Grease	2	<1	<1	4	<1	<1	2	<1
Fecal Coliform	180-12,000	<1-75,000	2500-30,000	750-90,000	2500-72,000	900-13,500	<1-1750	<1-9,000

All units are in mg/l except as noted; and pH has no unit, conductivity is in umho/cm, and fecal coliform is in organisms/100 ml.

*Questionable results.

TABLE 5.14

SUMMARY OF WET-WEATHER STREAM SAMPLING RESULTS

TRIBUTARIES - AUGUST 10, 1981

Sampling Site	FC 1	FC 2	PGR 1	PGR 2	PLR 1	PLR 2	EC 1	EC 2
Flow (cfs)	-	340	.3-.5	1.17	10.6-27.9	15.7-17.8	-	114
Temperature (°C)	23.5-24.5	23-24	22-24	23-24	23-24	19-22	22-24	20-21
pH	8.3-8.5	8.1-8.2	7.8-8.2	8.0-8.1	7.7-8.5	7.8-8.1	7.8-8.3	7.7-7.9
Conductivity	570-620	700-800	760-890	1210-1510	380-500	630-760	560-660	800-1050
D.O.	8.0-9.0	6.6-8.2	5.2-5.7	6.3-6.4	6.3-6.9	8.2-10.6	7.0-7.3	6.6-10.5
BOD_5	3-12	1-5	<1-4	11-12	4-8	1-5	<1-5	5-9
TSS	16-106	34-42	<1-20	<1-28	20-44	<1-14	<1-2	<1-6
Total P	.06-1.4	.06-.09	<.06-.54	.06-.84	<.06-.21	<.06-.48	<.06-.24	.15-.72
NO_3-N	.5-1.0	1.0-3.0	<.5-14.5	1.4-2.0	<.5-1.0	.5-.8	1.2-2.0	1.2-2.0
NH_4-N	<.1-.18	<.1-.14	<.1-.3	.41-1.3	<.1-.38	.035-.42	.02-.44	1.4-2.2
TKN	.9-2.3	1.1-1.5	.6-1.2	.7-2.4	.7-1.5	.7-1.9	.06-1.2	1.1-2.6
Cu	<.01-.08	<.01-.1	<.01	<.01-.01	<.01-.1	<.01	<.01-.01	.01-.07
Pb	<.01-.02	<.01	<.01	<.005-.04	<.005-.01	<.005-.025	<.01-.02	<.01
Zn	<.1	<.1	<.1	<.1	<.1-.1	<.1	<.1	<.1
Cr	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Cd	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Ni	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Oil & Grease	2	2	3	3	2	2	2	3
Fecal Coliform	>16	>16	>16	>16	>16	>16	>16	>16

All units are in mg/l except as noted; and pH has no unit, conductivity is in umho/cm, and fecal coliform is in organisms/100 ml.

TABLE 5.15

SUMMARY OF WET-WEATHER STREAM SAMPLING RESULTS

TRIBUTARIES - AUGUST 15, 1981

Sampling Site	FC 1	FC 2	PGR 1	PGR 2	PLR 1	PLR 2	EC 1	EC 2
Flow (cfs)	347	172-1600	.3-1.1	4.0-44.3	1-28	13-36	-	121-192
Temperature (°C)	20-23	23-23.5	23	22-25	23-24	21-24.5	21-22	21.5-22.5
pH	8.1	7.8-7.9	7.5-7.6	7.1-8.3	7.6-7.7	7.6-8.2	7.8-7.9	7.6
Conductivity	460-570	680-710	760-1000	320-2250	720-1030	590-1120	520-630	810-960
D.O.	2.6-7.2	6.8-8.2	6.4-7.3	5.0-8.2	6.9-8.6	5.3-9.6	7.6-7.8	4.1-8.0
BOD_5	1-7	3-7	2-11	5->25	4-8	3-16	2-7	3-9
TSS	<1-2	47-158	1-75	<1-324	<1-32	<1-18	1-6	<1-8
Total P	.03-.15	.03-.54	.08-.15	.15-1.3	.09-.45	.03-6	.03-.12	.12-.21
NO_3-N	<.4-.5	.5-.8	<.5	<.5-1.9	<.5-.5	.5-1.5	1.0-1.5	1.0-2.0
NH_4-N	<.1-.12	<.1-.19	<.1-.17	<.1-2.1	<.1	.28-5.4	<.1-.22	.63-1.8
TKN	.81-1.1	.9-2.6	.78-1.4	1.1-6.6	.93-1.6	.66-6.9	1.1-1.8	.9-2.4
Cu	<.01	.01	<.01-.02	.02-.06	<.01-.02	<.01-.02	<.01-.01	.03-.06
Pb	<.05	<.05	<.05-.14	<.05	<.005	<.005-.10	<.05	<.005-.12
Zn	<.031-.007	.02-.043	.031-.075	.036-.276	.022-.163	.015-.037	<.01-.166	.055-.118
Cr	<.01	<.01	<.01	<.01	<.01	<.01	<.01-.01	<.01-.01
Cd	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Ni	<.01	<.01-.05	<.01	<.01-.02	<.01	<.01-.03	<.01	.01-.03
Oil & Grease	2	2	2	4	2	2	.27-3	1
Fecal Coliform	>16	>16	>16	>16	>16	>16	>16	>16

All units are in mg/l except as noted; and pH has no unit, conductivity is in umho/cm, and fecal coliform is in organisms/100 ml.

TABLE 5.16

SUMMARY OF WET-WEATHER STREAM SAMPLING RESULTS

TRIBUTARIES - AUGUST 30, 1981

Sampling Site	FC 1	FC 2	PGR 1	PGR 2	PLR 1	PLR 2	EC 1	EC 2
Flow (cfs)	-	415-780	45	27-213	141	88-610	-	129-259
Temperature (°C)	21.0	21.8-22.9	20	21.1-22.7	20.3	19-24	21.0-26.0	20-25
pH	8.2	7.8	8.2	7.7-8.2	8.2	7.7-7.9	7.9	7.6-7.7
Conductivity	430	460-720	250	220-760	230	340-500	470-630	590-900
D.O.	7.0	6.0-7.2	7.1	2.1-7.8	7.1	5.3-7.2	8.6-9.9	4.8-6.8
BOD_5	3	10-18	4	7-36	4	3-22	<1-2	<1->22
TSS	449	188-504	266	89-1357	184	105-290	55-105	8-126
Total P	.42	.42-.96	.18	.30-1.9	.27	.42-.57	.08-.18	.15-.5
NO_3-N	.6	.2-.6	.6	<.1-.7	.6	.4-1.7	1.1-1.4	1.3-1.9
NH_4-N	.16	.43-.72	.2	.27-2.5	.28	.25-1.0	.07-.12	.44-2.0
TKKN	1.4	1.7-5.1	1.7	1.1-13	1.2	.84-3.3	.71-.93	.42-2.5
Cu	.02	.03-.05	-	.03-.05	<.01	.03-.05	<.01	.01-.05
Pb	.10	.06-.40	-	.02-.18	.16	.02-.14	.1	.04-.18
Zn	.09	.07-.11	-	.08-.19	.16	.09-.26	.02	.06-.12
Cr	<.01	.02-.03	-	<.01	.02	<.01-.03	<.01	<.01
Cd	<.01	<.01	-	<.01	<.01	<.01	<.01	<.01
Ni	<.02	<.03-.04	-	<.01-.03	<.04	<.01-.03	<.01	<.02-.03
Oil & Grease	3	5	4	11	5	2	1	3
Fecal Coliform	100	10^4-10^5	10^4	10^3-10^5	10^3	10^4-10^5	10^4	10^2-10^5

All units are in mg/l except as noted; and pH has no unit, conductivity is in umho/cm, and fecal coliform is in organisms/100 ml.

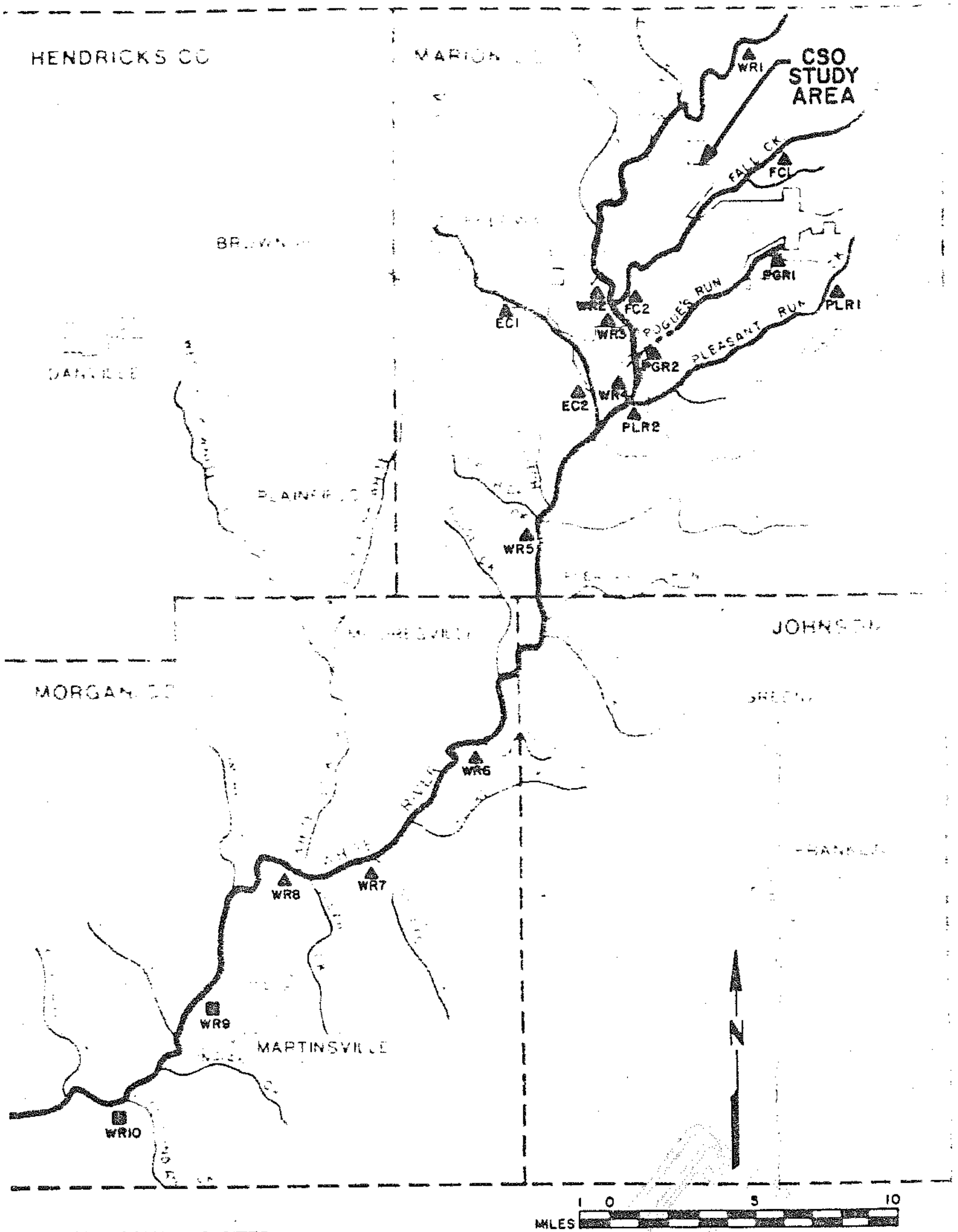
TABLE 5.17

SUMMARY OF WET-WEATHER STREAM SAMPLING RESULTS

TRIBUTARIES - SEPTEMBER 29, 1981

Sampling Site	FC 1	FC 2	PCR 1	PGR 2	PLR 1	PLR 2	EC 1	EC 2
Flow (cfs)	282-298	100-185	1.4-14.0	4.9-115.8		45-108	-	141-217
Temperature (°C)	13-15	16	12.1-13.4	15-17.4	12.0-14.0	13.4-14.3	13-15	14.7-16
pH	7.9	7.9	7.8-7.9	7.8	7.8-7.0	7.7-7.9	8.0	7.6-7.7
Conductivity	560-580	750-820	400-750	240-740	340-720	420-710	390-640	630-990
D.O.	8.9-9.4	7.2-8.3	8.0-9.0	7.5-8.2	8.2-9.0	8.1-9.6	9.8-10.8	7.7-8.7
BOD_5	3-9	5-10	4-14	7-36	6-10	8-33	4-6	7-17
TSS								
Total P								
NO_3-N								
NH_4-N	.05-.18	.31-.48	.08-.12	.75-3.2	.12-.15	.18-2.4	.03-.31	1.5-4.8
TKN								
Cu								
Pb								
Zn								
Cr								
Cd								
Ni								
Oil & Grease								
Fecal Coliform	<10->1000	<10-50	<10->1000	<10	<10->1000	<10->1000	<10-300	20->1000

All units are in mg/l except as noted; and pH has no unit, conductivity is in umho/cm, and fecal coliform is in organisms/100 ml.



▲ STREAM SAMPLING SITES

■ DO MONITORING SITES

HNTB
HOWARD NEEDLES TAMMEN & BERGENDOFF
ARCHITECTS ENGINEERS PLANNERS
INDIANAPOLIS, INDIANA

FIGURE
STREAM SAMPLING
LOCATIONS MAP
INDIANAPOLIS CSO STUDY